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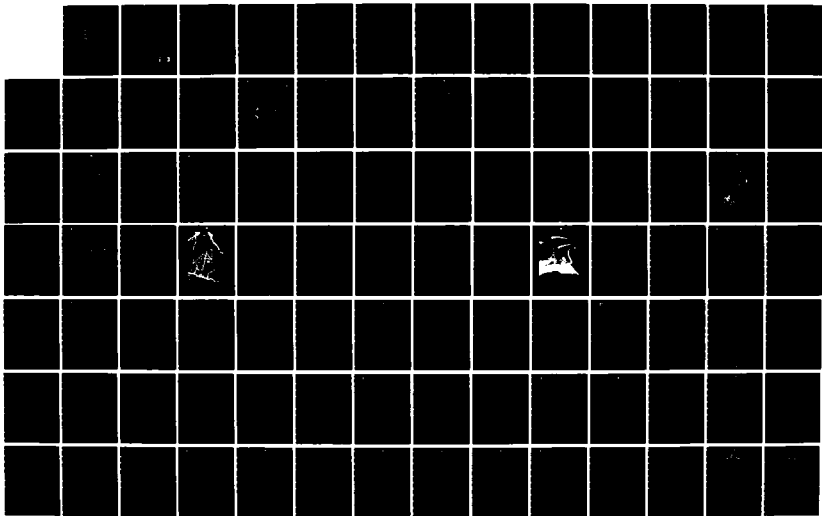
INSTALLATION RESTORATION PROGRAM PHASE I: RECORDS
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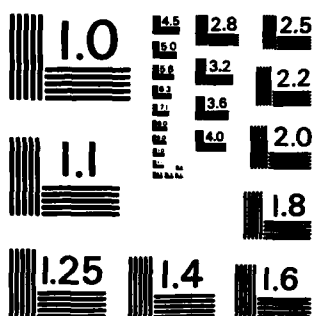
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INSTALLATION RESTORATION PROGRAM
PHASE I: RECORDS SEARCH
WILLOW GROVE AIR RESERVE FACILITY
WILLOW GROVE, PENNSYLVANIA

Prepared For:

UNITED STATES AIR FORCE RESERVE
ROBINS AFB, GEORGIA 31098

NOVEMBER 1984

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By:

Roy F. Weston, Inc.
Weston Way
West Chester, Pennsylvania 19380

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HEADQUARTERS AIR FORCE RESERVE
ROBINS AIR FORCE BASE, GEORGIA 31098

21 NOV 1984

REPLY TO
ATTN OF: DEPV (Mr Garrett/5755)

SUBJECT: Installation Restoration Program (IRP) Phase I Final Report for Willow Grove ARF PA

TO: See Distribution

The attached report is forwarded for your information/action. This report is the initial phase of an Air Force program to identify and fully evaluate problems associated with past hazardous material disposal and spill sites on Air Force facilities, to control the migration of hazardous contamination from such facilities, and to control hazards to the health and welfare that may have resulted from past operations.

FOR THE COMMANDER

Jerrold F. Smith
JERROLD F. SMITH

Acting DCS/Engineering and Services

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Phase I IRP Report, Willow Grove
ARF, PA

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TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
	EXECUTIVE SUMMARY	ES-1
1	INTRODUCTION	1-1
	1.1 Background and Authority	1-2
	1.2 Purpose and Scope of the Assessment	1-2
	1.3 Methodology	1-4
2	INSTALLATION DESCRIPTION	2-1
	2.1 Location, Size and Boundaries	2-1
	2.2 History	2-3
	2.2.1 913th Tactical Air Group	2-3
	2.2.2 111th Pa Air National Guard	2-5
	2.3 Organization and Mission	2-6
	2.3.1 913th Tactical Airlift Group	2-6
	2.3.2 111th Pa Air National Guard	2-8
3	ENVIRONMENTAL SETTING	3-1
	3.1 Meteorology	3-1
	3.2 Geography	3-3
	3.2.1 Topography	3-3
	3.2.2 Soils	3-3
	3.3 Surface Water Resources	3-6
	3.3.1 Surface Drainage	3-6
	3.3.2 Surface Water Quality	3-8
	3.3.3 Surface Water Use	3-12



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TABLE OF CONTENTS
(Con't)

<u>Section</u>	<u>Title</u>	<u>Page</u>
3.4	Groundwater Resources	3-13
3.4.1	Background Geology	3-13
3.4.2	Hydrogeologic Units	3-14
3.4.3	Groundwater Quality	3-20
3.4.4	Groundwater Use	3-28
3.5	Biotic Environment	3-34
3.6	Sensitive Environmental Features	3-35
3.7	Summary of Environmental Conditions	3-36
 4	 FINDINGS	 4-1
4.1	Introduction	4-1
4.2	913th Tactical Air Group	4-1
4.2.1	Overview of Industrial Operations	4-1
4.2.2	Hazardous Waste Generation and Management	4-5
4.3	111th Pa Air National Guard	4-13
4.4	Fuels Management	4-13
4.4.1	POL Fuel Area	4-13
4.4.2	Fuel Spills	4-22
4.5	Industrial Waste Control - Sanitary Sewer and Storm Sewer Systems	4-25
4.6	Site Findings	4-28
4.6.1	POL Area - Site No. 1	4-28
4.6.2	Open Storage Area #42 - Site No. 2	4-32

TABLE OF CONTENTS
(Con't)

Section	Title	Page
	4.6.3 Ponding Basin - Site No. 3	4-34
	4.6.4 Washrack Area - Site No. 4	4-35
	4.6.5 Building #330 Waste Oil Storage Area - Site No. 5	4-37
	4.6.6 Heating Plant - Site No. 6	4-38
	4.6.7 Old Well House - Site No. 7	4-39
5	CONCLUSIONS	5-1
	5.1 Introduction	5-1
	5.2 POL Area - Site No. 1	5-1
	5.3 Open Waste Storage Area #42 - Site No. 2	5-4
	5.4 Ponding Basin - Site No. 3	5-5
	5.5 Washrack - Site No. 4	5-5
	5.6 Building #330 Waste Oil Storage Area - Site No. 5	5-6
	5.7 Heating Plant - Site No. 6	5-6
	5.8 Old Well House - Site No. 7	5-7
6	RECOMMENDATIONS	6-1
	6.1 Introduction	6-1
	6.2 POL Area - Site No. 1	6-1
	6.3 Open Storage Area #42 - Site No. 2	6-3
	6.4 Ponding Basin - Site No. 3	6-6



TABLE OF CONTENTS
(Con't)

<u>Section</u>	<u>Title</u>	<u>Page</u>
	6.5 Washrack Area - Site No. 4	6-8
	6.6 Building #330 Waste Oil Storage - Site No. 5	6-9
	6.7 Heating Plant - Site No. 6	6-9
	6.8 Old Well House - Site No. 7	6-10
	6.9 General Confirmation Recommendations	6-10
	6.9.1 Soil Borings and Well Installations	6-10
	6.9.2 Analytical Parameters	6-11
 Appendix		
A	Resumes of the WESTON Team	A-1
B	List of Interviewees	B-1
C	List of Outside Agencies	C-1
D	Hazard Assessment Rating Methodology	D-1
E	Site Harm Score Calculations	E-1
F	Photographs	F-1
G	Glossary of Terms and Abbreviations	G-1
H	References	H-1

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
ES-1	Location of Sites Recommended for Confirmation	ES-5
1-1	Decision Tree	1-6
2-1	Location of Willow Grove ARF	2-2
2-2	Facility Locations at Willow Grove ARF	2-4
3-1	Soils Conditions at Willow Grove ARF	3-4
3-2	Surface Drainage	3-7
3-3	Flood-Prone Area	3-9
3-4	Geological Map of Stockton Formations	3-15
3-5	Bedrock Surface Elevations	3-17
3-6	Water Table Map	3-21
3-7	Location of Water Supply Wells	3-30
4-1	Major Buildings and Facilities-913th TAG	4-3
4-2	Hazardous Waste Accumulation Points and Storage Locations at 913th TAG	4-6
4-3	Hazardous Waste Management at Willow Grove ARF	4-7

LIST OF FIGURES
(Con't)

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
4-4	Major Buildings and Facilities-111th PaANG	4-14
4-5	Location of Fuel Storage and Waste Oil Tanks at Willow Grove ARF	4-20
4-6	Sanitary Sewer System	4-27
4-7	Location of Sites Recommended for Confirmation	4-29
6-1	Monitoring Well Profile	6-5

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
ES-1	Summary of Waste Types and HARM Scores for Confirmation Sites	ES-6
ES-2	Recommended Phase II Sampling Program	ES-8
3-1	Climatic Conditions at Willow Grove ARF	3-
3-2	Soils at Willow Grove ARF	3-5
3-3	Chemical Analysis of Water from Little Neshaminy Creek at Neshaminy	3-10
3-4	Statistical Summary of Background Ground- water Quality - Stockton Formation	3-22
3-5	Maximum Reported Concentrations of Volatile Organic Compounds in Groundwater	3-24
3-6	Ranges of TCE and PCE Concentrations in Willow Grove Naval Air Station Supply Wells	3-25
3-7	Inorganic Parameter Concentrations in Willow Grove Air Station Supply Wells	3-29
3-8	Supply Well Specifications - Willow Grove Naval Air Station	3-31



LIST OF TABLES
(Con't)

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
3-9	Groundwater Pumpage in 1980 by Public Water Suppliers and Government Facilities	3-33
4-1	Hazardous Material/Waste Generation - 913th TAG	4-9
4-2	Shop-by-Shop Hazardous Materials/Wastes Generation - 913th TAG	4-10
4-3	Hazardous Material/Waste Generation - 111th PaANG	4-15
4-4	Shop-By-Shop Hazardous Materials/Wastes Generation - 111th PaANG	4-16
4-5	Fuel Storage Tanks at Willow Grove ARF	4-19
4-6	Summary of Small Quantity Fuel Spill Responses	4-23
5-1	Summary of Waste Types and HARM Scores for Confirmation Sites at Willow Grove ARF	5-2
6-1	Recommended Phase II Sampling Program	6-2
6-2	Minimum Well Construction Requirements	6-4
6-3	Recommended List of Analytical Parameters for Selected Sites at Willow Grove ARF	6-7



EXECUTIVE SUMMARY

The Department of Defense (DoD) has developed a program to identify and evaluate past hazardous material disposal sites on DoD property, to control the migration of hazardous contaminants, and to control hazards to health or welfare that may result from these past disposal operations. This program is called the Installation Restoration Program (IRP). The IRP has four phases consisting of Phase I, Initial Assessment/Records Search; Phase II, Confirmation and Quantification; Phase III, Technology Base Development/Evaluation of Remedial Alternatives; and Phase IV, Operations/Remedial Actions. Roy F. Weston, Inc. was retained by the United States Air Force to conduct the Phase I, Initial Assessment/Records Search for Willow Grove Air Reserve Facility under Contract No. F08637-83-G0009.

INSTALLATION DESCRIPTION

See #1473 (cont)

The Willow Grove Air Reserve Facility (ARF) is located approximately 23 miles north of Philadelphia, Pennsylvania in southeastern Montgomery County. The ARF is located adjacent to and northeast of the Willow Grove Naval Air Station.

The ARF consists of about 162 acres and is occupied by the 913th Tactical Air Group. A portion of the facility is leased to the 111th Pennsylvania Air National Guard.

At the present time, there are 964 personnel attached to the 913th TAG, most of which are part-time Air Reservists. The 111th PaANG has about 830 personnel assigned, most of which are part-time Air National Guardsmen.

ENVIRONMENTAL SETTING

The surrounding land use at Willow Grove ARF has been described as "urban sprawl", radiating out from Philadelphia. The land west and north of the base is relatively open agricultural land, and scattered industrial and residential development and golf courses. The areas to the north are environmentally sensitive and zoned low density residential, and are expected to remain largely vacant due to lack of utility service. The areas south and east of the Air Reserve Facility are densely developed for residential, industrial and commercial uses.

The following environmental conditions are of particular importance in the evaluation of past hazardous waste disposal practices at Willow Grove ARF:

1. The mean annual precipitation is 41 inches, the net precipitation is 18 inches and the one-year, 24-hour rainfall event is estimated to be 2.7 inches. These data indicate there is moderate to high potential for infiltration into the surface soils on the base, and that there is moderate to high potential for runoff and erosion.
2. The natural soils on the base are loams and silt loams. Soil permeabilities range from 0.2 to 6.3 inches per hour, which correspond to slow to moderately rapid permeability. Soils data indicate that recharge of infiltration through the soil will be slow to moderately rapid. The soils and other consolidated material overlying the bedrock are considerably more porous than the bedrock.

3. Surface water is controlled on base by open ditches, and underground storm sewers. There are no natural surface water features on the base. No 100-year flood plain has been delineated on the base, but highly localized flooding does occur.
4. Bedrock in the vicinity of Willow Grove is the Stockton Formation, which consists primarily of gray and red sandstone with interlayers of red shale. The Stockton formation lies approximately 10 feet below the surface at Willow Grove, and as far as 15 to 20 feet below the surface in areas where structural fill has been placed.
5. Groundwater is an important resource in the vicinity of Willow Grove. The Stockton formation, the bedrock aquifer, is an important source of private and public water supplies. The water table in the unconsolidated upper aquifer fluctuates seasonally. This fluctuation would have a significant influence on the direction and rate of contaminant migration in both the unconsolidated and bedrock aquifers, because primary source of recharge for the bedrock aquifer is the unconsolidated aquifer.
6. There are no known federal endangered or threatened species which inhabit the area.

METHODOLOGY

During the course of this project, interviews were conducted with base personnel (past and present) familiar with past waste disposal practices; file searches were performed for past hazardous waste activities; interviews were held with local, state and Federal agencies; and field and helicopter reconnaissance inspections were conducted at past hazardous waste activity

sites. Seven sites were identified as potentially containing hazardous contaminants resulting from past activities. These sites have been assessed using a Hazard Assessment Rating Methodology (HARM) which takes into account factors such as site characteristics, waste characteristics, potential for contaminant migration and waste management practices. The details of the rating procedure are presented in Appendix D. The rating system is designed to indicate the relative need for follow-on action in Phase II of the IRP Program.

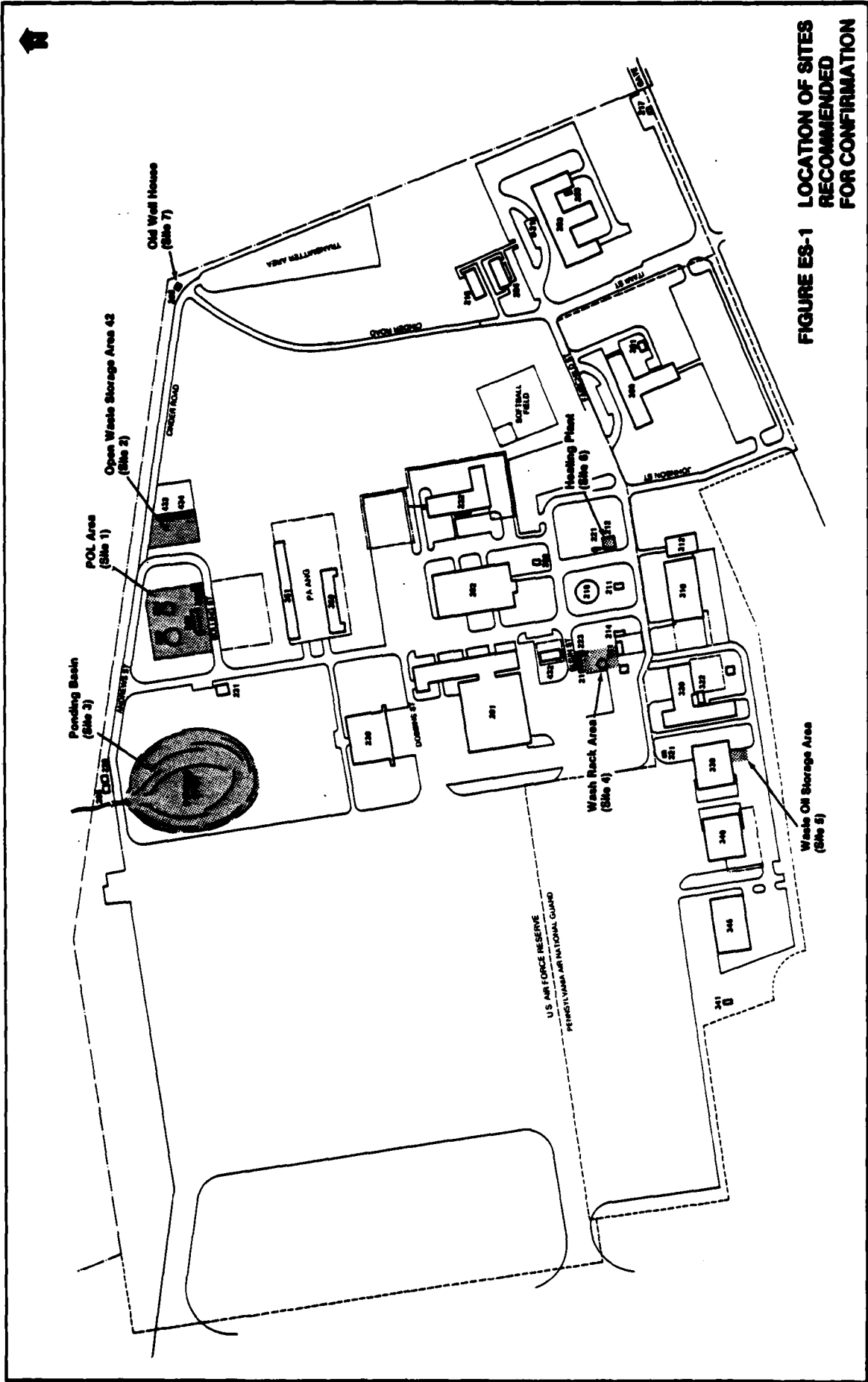
FINDINGS AND CONCLUSIONS

All seven sites identified during the study were evaluated as having a high potential for environmental contamination, primarily due to the fact that the Stockton formation, which is the bedrock aquifer for the region, lies about ten feet below the surface at Willow Grove. The Stockton formation is an important source of private and public water supplies.

Figure ES-1 shows the locations of the seven sites recommended for confirmation. Table ES-1 presents the results of the HARM score rating analysis and indicates the types of contamination of concern at each site.

RECOMMENDATIONS

The recommendations shown in Table ES-2 are made for work to be performed in Phase II (Confirmation and Quantification). The recommended actions are generally one-time sampling and analytical programs. They are designed on a site-by-site basis to verify the presence or absence of contamination at a site, and to further assess the potential for adverse environmental impact from contamination should it be present at a site.



**FIGURE ES-1 LOCATION OF SITES
RECOMMENDED
FOR CONFIRMATION**



TABLE ES-1

SUMMARY OF WASTE TYPES AND HARM SCORES
FOR CONFIRMATION SITES AT WILLOW GROVE ARF

Site Number	Site Name	Waste Type	HARM Score
1	POL Area	JP-4 Fuel JP-4 Fuel Sludge 1100 Aviation Fuel	82
2	Open Waste Storage Area #42	Engine Oil Hydraulic Fluid Solvents (PD-680, 1,1,1-Tri-chloroethane, Lacquer Thinner, Paint Stripper) Methanol De-Icing Fluid (Ethylene Glycol)	79
3	Ponding Basin	JP-4 Fuel Other Fuel Oils Solvents	70
4	Washrack Area	Super II Detergent Solvents (PD-680, Dexyl) Paint Strippers (Lacquer and Enamel Stripper, MEK)	69
5	Building #330 Waste Oil Storage Area	Engine Oils Hydraulic Fluids Solvents	69



**TABLE ES-1
(Con't)**

**SUMMARY OF WASTE TYPES AND HARM SCORES
FOR CONFIRMATION SITES AT WILLOW GROVE ARF**

Site Number	Site Name	Waste Type	HARM Score
6	Heating Plant	#6 Fuel Oil #2 Fuel Oil Solvents (Petroleum Naptha) Corrosion Inhibitor (Acidine) Liquid Oxygen Scavenger Alkalinity Control Agent	66
7	Old Well House	Paint and Paint Wastes Paint Thinners Solvents (Toluene)	57

TABLE ES-2

**RECOMMENDED PHASE II SAMPLING PROGRAM
WILLOW GROVE ARF**

Site No.	Site Name	Harm Score	Recommended Phase II Sampling Program				
			No. of Soil Borings ¹	No. of Monitor Wells ²	Maximum	No. of GW Samples ⁴	No. of Surface Water
					No. of Soil/Sed Samples ³		
1	POL Area	82	6	1	18	5	—
2	Open Storage Area No. 42	79	6	4	18	4	—
3	Ponding Basin	70	—	—	6	3 (seeps)	6
4	Washrack Area	69	3	3	14	5 (3 wells, 2 seeps)	—
5	Bldg. 330 Waste Oil Storage Area	69	—	1	8 (5 hand auger)	1	—
6	Heating Plant	66	—	—	5 (all hand auger)	—	—
7	Old Well House	57	—	—	1	2	1
TOTALS			15	9	71	20*	7

* 20 = 2 from AF-2, 4 from existing monitor wells, 9 from new monitor wells, 5 from seeps

NOTES:

- ¹ Soil borings refer to hollow stem auger holes not finished as monitor wells.
- ² All monitor wells to be drilled 20 feet into bedrock, screened above seasonal high water and sand packed.
- ³ Sediment samples to be preserved for analysis to be determined by use of on-site OVA.
- ⁴ A seep is defined as an area of ground where water or other liquid oozes from the earth; water collected from a seep is treated as groundwater.



SECTION 1

INTRODUCTION

1.1 BACKGROUND AND AUTHORITY

The United States Air Force, due to the nature of its primary mission, has long been engaged in a wide variety of operations dealing with toxic and hazardous materials. This circumstance, coupled with the enactment of environmental legislation at the Federal, state, and local levels of government, has required action to be taken to identify and eliminate hazards related to past disposal sites in an environmentally responsible manner.

The primary federal legislation governing the disposal of hazardous waste is the Resource Conservation and Recover Act (RCRA), as amended. Under Section 6003 of the Act, Federal agencies are directed to assist EPA and make available information on past disposal practices. Section 3012 of RCRA requires each state to inventory disposal sites and make information available to requesting agencies. To assure compliance with these hazardous waste regulations, DoD issues Defense Environmental Quality Program Policy Memoranda (DEQPPM), which mandated a comprehensive Installation Restoration Program (IRP).

The current DoD IRP policy is contained in DEQPPM 81-5, dated 11 December 1982 and implemented by Air Force message dated 21 January 1982. DEQPPM 81-5 reissues,



consolidates, and amplifies all previous directives and memoranda on the Installation Restoration Program. DoD policy is to identify and fully evaluate suspected problems associated with past hazardous contamination from Air Force facilities, and to control hazards to health or welfare that resulted from past operations. The IRP will be the basis for U.S. Air Force response actions under the provisions of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, and directed by Executive Order 12316, and 40 CFR 300, Subpart F, National Contingency Plan. CERCLA is the primary legislation governing remedial action at past hazardous waste disposal sites.

1.2 PURPOSE AND SCOPE OF THE ASSESSMENT

The Installation Restoration Program has been developed as a four-phased program:

- Phase I - Initial Assessment (Records Search)
- Phase II - Confirmation/Quantification
- Phase III - Technology Base Development
- Phase IV - Operations/Remedial Actions

WESTON was retained by the United States Air Force to conduct the Phase I Records Search at Willow Grove Air Reserve Facility under Contract No. F08637-83-G0009. Two facilities were included in this records search: the Air Force Reserve Facility (913th TAG) and the Pennsylvania Air National Guard Facility (111th PaANG). The two facilities, encompassing 162 acres, are separate operations, housed at separate but adjacent facilities. This report contains a summary and an evaluation of the information collected during Phase I of the IRP.

The objective of the first phase of the program is to identify the potential for environmental contamination from past waste disposal practices at Willow Grove to assess the probability for contaminant migration, and to develop conclusions and recommendations for follow on actions. The Phase I program included a pre-performance meeting, an on-site base visit, a review and analysis of the information collected, and preparation of this report.

The pre-performance meeting was held at Willow Grove on 15 May 1984. The purpose of this meeting was to define responsibilities of the project participants, establish a program schedule, transfer information to the project contractor, and to tour the base facilities.

WESTON's team conducted the on-site base visit 25-29 June 1984. Activities performed during the on-site visit included a detailed search of installation records, tours of the installation, and interviews with past and present base personnel. At the conclusion of the on-site base visit, an outbriefing was held with representatives of the U.S. Air Force Reserve and the Air National Guard to discuss preliminary findings.

The following individuals comprised WESTON's record search team:

- o Raymond W. Kane, P.E., Project Manager, (M.S. Civil Engineering, 1976)
- o Allison L. Dunn, Hydrogeologist, (M.S., Geology, 1981)
- o Michael F. Coia, Chemical Engineer, (M.S., Environmental Engineering, 1981)
- o Jennifer L. Kauffman, Environmental Planner, (M.R.P., Regional Planning, 1979)



Resumes of these key team members are provided in Appendix A.

1.3 METHODOLOGY

The Willow Grove records search began with a review of past and present industrial operations and was conducted at the base. Information was obtained from available records, such as shop files and real property files, and from interviews with past and present base employees from the various operating areas. A list of the 29 interviewees by position and approximate years of service is presented in Appendix B.

Prior to the base interviews, the applicable federal, state and local agencies were contacted for pertinent base related environmental data. The agencies contacted are listed in Appendix C.

The next step in the activity review process was to identify all hazardous waste generators and to determine the past management practices regarding the use, storage, treatment, and disposal of hazardous materials from the various Air Force Reserve and Air National Guard operations on the Base. Included in this part of the activities review was the identification of all known past disposal sites and other possible sources of contamination, such as spill areas.

A general ground tour of the identified sites was then made by the WESTON record search team to gather site-specific information, including general site conditions, visual evidence of environmental stress, and the presence of nearby drainage ditches or surface water



bodies. A helicopter survey was also conducted. These water bodies were inspected for any obvious signs of contamination or leachate migration.

A decision was then made, based on all of the above information, whether a potential exists for hazardous material contamination at any of the identified sites using the Flow Chart shown in Figure 1-1. If no potential existed, the site was deleted from further consideration. If minor operations and maintenance deficiencies were noted during the investigation, the conditions were reported to the Base Environmental Coordinator for remedial action.

For those sites where a potential for contamination was identified, the potential for migration of the contamination across installation boundaries was evaluated by considering site-specific ground- and surface water conditions. If there is potential for on-base contamination or other environmental concerns, the site was referred to the Base Environmental Coordinator for further action. If the potential for contaminant migration is considered significant, the site is evaluated and prioritized using the Hazard Assessment Rating Methodology (HARM), described in Appendix D.

The site rating indicates the relative potential for environmental impact at each site. For those sites showing significant potential, recommendations are made to quantify the potential contaminant migration problem under Phase II of the Installation Restoration Program. No Phase II work is recommended for those sites showing a low potential.

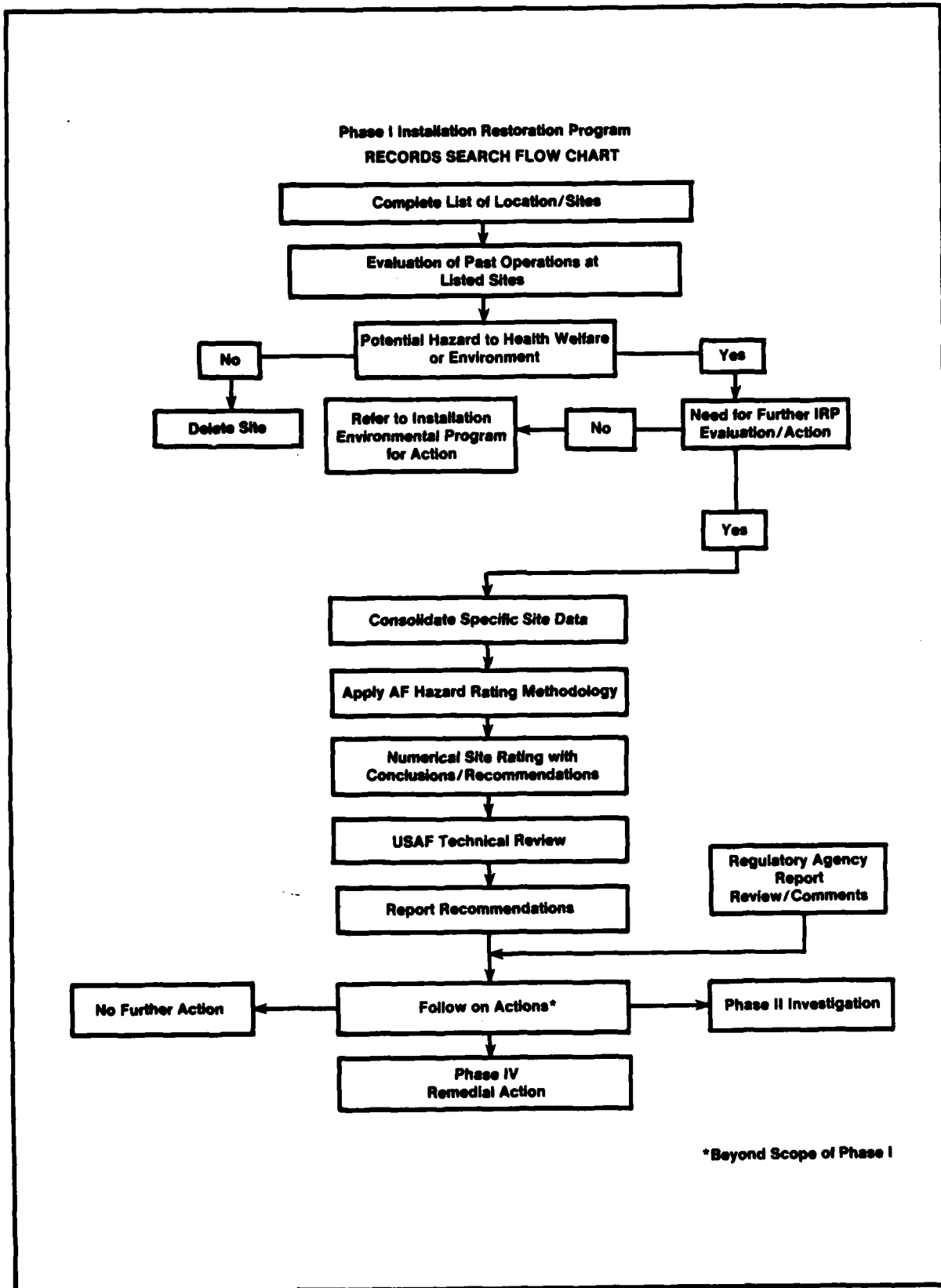


FIGURE 1-1 PHASE I INSTALLATION RESTORATION PROGRAM



SECTION 2

INSTALLATION DESCRIPTION

2.1 LOCATION, SIZE AND BOUNDARIES

The Willow Grove Air Reserve Facility is located northeast of Willow Grove Naval Air Station, and is owned by the U.S. Air Force. A portion of the facility is leased to PaANG. Willow Grove is located approximately 23 miles north of Philadelphia in southeastern Montgomery County, immediately adjacent to Bucks County. Figure 2-1 shows the location of the facility within the region.

The Air Reserve Facility is located in Horsham Township, just west of Warminster and Warrington Townships in Bucks County. The surrounding land use has been described as "urban sprawl", radiating out from Philadelphia. The land west and north of the base is relatively open agricultural land, and scattered industrial and residential development and golf courses. Sewer service is planned in the western area, and development is expected to follow. The areas to the north are environmentally sensitive and zoned low density residential, and are expected to remain largely vacant due to lack of utility service. The areas south and east of the Air Reserve Facility are densely developed for residential, industrial and commercial uses. The Federal government is in the process of acquiring lands in the north and south clear zones and additional easements to the north to preclude additional development which conflicts with flight patterns.

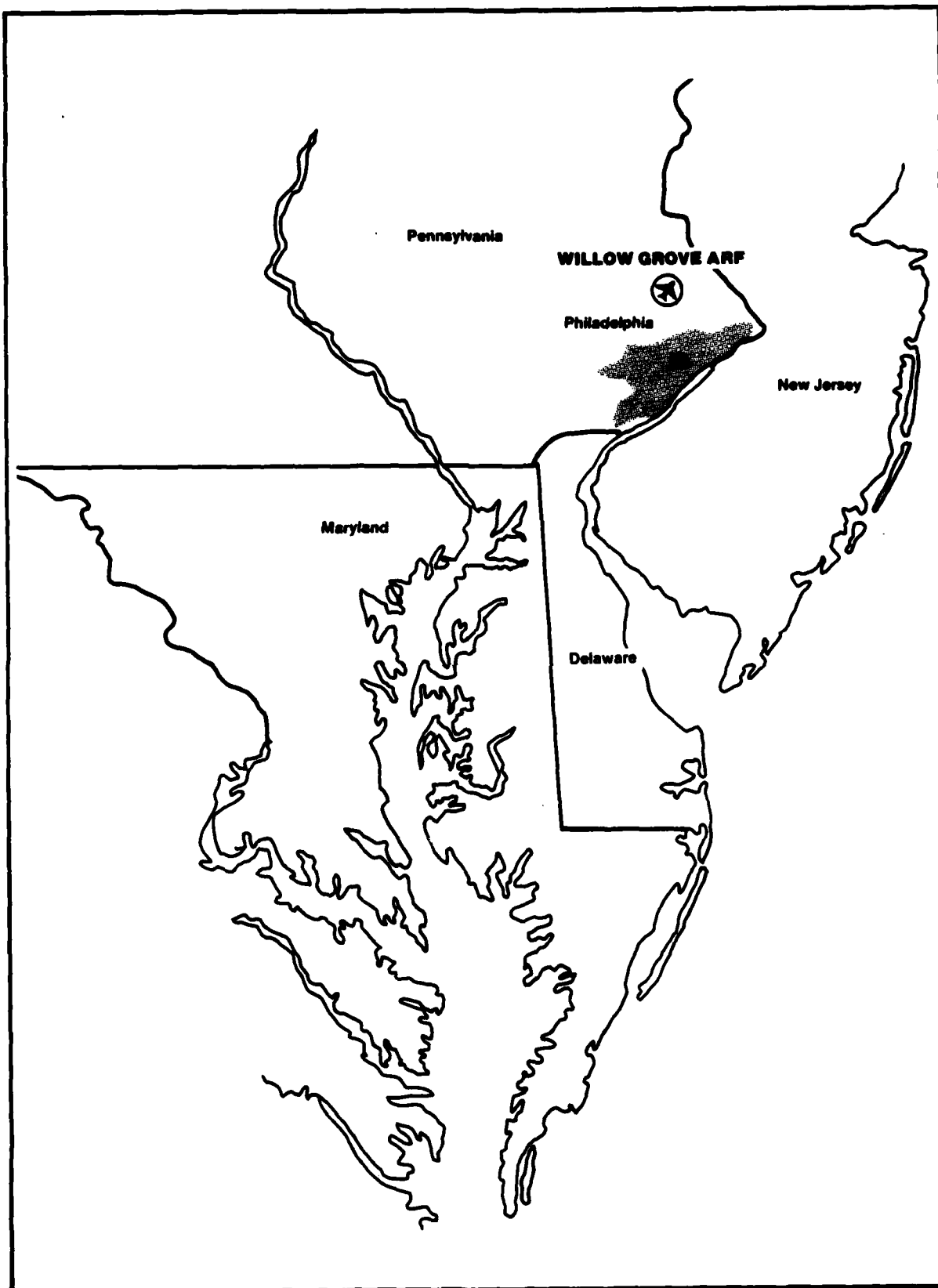


FIGURE 2-1 LOCATION OF WILLOW GROVE ARF

The Willow Grove Air Reserve Facility occupies approximately 162 acres of land. The Pennsylvania Air National Guard leases and occupies 45 acres in the southern third of the site, while the U.S. Air Force Reserve owns the remainder. The facility locations are shown in Figure 2-2.

2.2 HISTORY

2.2.1 History of the 913th Tactical Airlift Group

The 913th Tactical Air Group evolved from the 512th Troop Carrier Group, which has been located at the Willow Grove Air Reserve Facility since 1958.

The 512th Troop Carrier Group was originally trained and based at the municipal airport in Reading, Pennsylvania and was activated during the Korean War. In 1958, the 512th Troop Carrier Group was officially located at the new Willow Grove Air Reserve Facility. The 913th Troop Carrier Group, host group at Willow Grove, and 912th Troop Carrier Group were assigned to the 512th until 1965 when they were reassigned to the 302nd TCW in Clinton, Ohio. In 1966, the 912th and 913th TCG's were reassigned to the 514th Troop Carrier Wing at McGuire AFB, New Jersey.

The 912th and 913th were renamed Tactical Airlift Groups in July 1967. The 913th participated in the YC-119 program at Willow Grove - the forerunner of the AC-119 gunship used in Viet Nam. In August 1967, fourteen crews of the South Vietnam Air Force trained on C-119 aircraft at Willow Grove.



Legend
Pa ANG Property

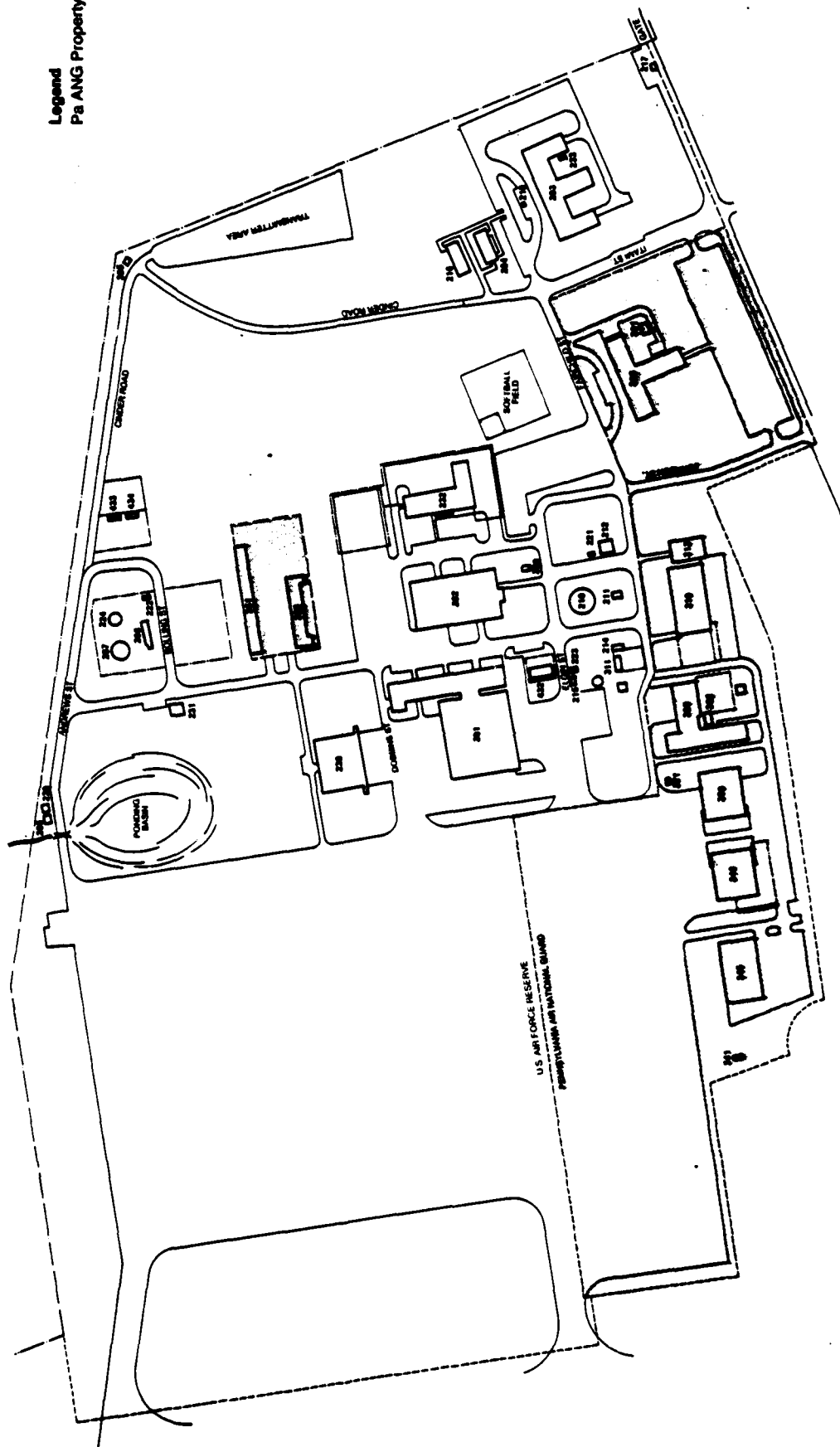


FIGURE 2-2 FACILITY LOCATIONS,
WILLOW GROVE ARF

The 912th TAG was deactivated in 1968 and became the 912th Military Airlift Group (associate) at Dover AFB, Delaware. Plans for the deactivation of the 913th TAG were made in 1969, but instead the Group was given a new mission in 1970: "to fly 'Hercules' C-130 aircraft" - and has remained at Willow Grove Air Reserve Facility. At the present time, eight C-130E Hercules aircraft are assigned at the Willow Grove Air Reserve Facility.

2.2.2 History of the 111th Tactical Air Support Group (PaANG)

The 111th PaANG evolved from the 103rd Observation Squadron, and has been located at Willow Grove since 1963.

The 103rd Observation Squadron was originally formed in Philadelphia in 1924, part of the 28th Division Aviation, Pennsylvania National Guard. Through the years, the 103rd has operated from a number of locations and performed a variety of missions. In 1941, the Observation Squadron became a Reconnaissance Squadron. In 1943, the 103rd was redesignated as the 40th Photo Reconnaissance Squadron. The 40th was inactivated in 1945, and was reactivated 1946 as the 103rd Bomb Squadron in Philadelphia. Federal recognition was received in December 1948. The Philadelphia Air National Guard became the 111th, a fully constructed self-supported tactical flying unit which served in Korea.

The 111th was redesignated as a Fighter Interceptor Group in May 1955, with a day fighter mission. Beginning in 1955, the unit underwent major reorganization due to cutbacks. The Group's mission changed from day fighter to all weather air defense assignment.



In April 1963, the Group was officially redesignated as an Air Transport Unit. The 111th was relocated to Willow Grove in March 1963. In May 1969, the unit acquired its present designation, the 111th Tactical Air Support Group, and was equipped with the U-3 and O-2A's as interim aircraft. At the present time, nineteen A-37 'Dragonfly' aircraft and nine, C-131D are assigned to the 111th PaANG.

2.3 ORGANIZATION AND MISSION

2.3.1 Organization and Mission of the 913th Tactical Airlift Group

The primary mission of the 913th Tactical Airlift Group is to achieve, through training, capabilities for:

- air transportation for airborne forces and their equipment and supplies;
- long-range movement of personnel, equipment and supplies, including air evacuation of patients;
- material support, including supply services and organizational and field maintenance of assigned aircraft;
- operation and maintenance of base facilities in support of assigned or attached units;
- operation and maintenance of communications facilities and equipment in support of USAFR flying activities at airport and air-base type installations;
- medical support to assigned units;
- operations of air terminals for airlift; and
- loadmaster services for aerial delivery of heavy loads.



The secondary mission is to operate and maintain an air force installation at the Willow Grove Air Reserve Facility.

The 913th Tactical Airlift Group is comprised of the following units:

- HQ 913th Tactical Airlift Group
- 913th Consolidated Aircraft Maintenance Squadron
- 327th Tactical Airlift Squadron
- 913th Civil Engineering Squadron
- 913th Combat Support Squadron
- 913th Tactical Clinic Unit
- 913th Communications Flight (Support)
- 913th Weapons System Security Flight
- 913th Aerial Port Flight
- 913th Mobility Support Flight

At the present time, there are 818 personnel attached to the 913th TAG. The personnel include the following:

<u>No. of Personnel</u>	
Air Reservists (Part-time)	693
Air Reserve Technicians	116
Civilians (Host and Tenants)	151
Active Duty Air Advisors	<u>4</u>
TOTAL Personnel	964

The 913th TAG is currently part of the 459th Tactical Airlift Wing at Andrews AFB, Maryland.

2.3.2 Organization and Mission of the 111th Pa Air National Guard

The mission of the 111th Air National Guard is to provide units organized, equipped and trained to function efficiently at existing strengths in the protection of life and property and preservation of peace, order and public safety, under competent orders of state authorities .

In addition, the 111th PaANG is to:

- provide operationally-ready combat units, combat support units, and qualified personnel for active duty in the Air Force;
- to protect life and property and preserve peace, order, and public safety; and to
- organize, train and equip assigned personnel to provide operationally-ready Direct Air Support Center (DACS) Squadrons and Tactical Air Support Squadrons (TASSq) to the Tactical Air Control System (TACS).

The 111th PaANG is composed of the following units:

- HQ 111th Tactical Air Support Group
- 103rd Tactical Air Support Group
- 111th Tactical Clinic
- 111th Civil Engineering Flight
- 111th Combat Support Squadron
- 111th Communications Flight (SPT)
- 111th Direct Air Support Center Squadron
- 140th Weather Flight (Attached)



At the present time, 829 personnel are assigned to the 111th PaANG at Willow Grove. The personnel include

No. of Personnel

Air National Guardsmen	
(Part-time)	689
Air Technicians	138
Active Duty Air Advisors	<u>2</u>
TOTAL Personnel	829

The 111th PaANG is currently assigned to the 105th TASW, Westchester County Airport, White Plains, NY.

SECTION 3**ENVIRONMENTAL SETTING****3.1 METEOROLOGY**

Willow Grove is located in the Southeastern Coastal Plain/Allegheny Plateau physiographic unit. The Atlantic Ocean to the east and Appalachian Mountains to the west have a moderating influence on local climate. January is the coldest month, with an average temperature of 32.3°F, and July is the warmest month, with an average temperature of 75.6°F, (NOAA, 1974).

On the average, 41.18 inches of precipitation falls annually. Maximum rainfall occurs in late summer in connection with local thunderstorms. The average annual snowfall is 20.3 inches (NOAA, 1974). Climatic data is summarized in Table 3-1.

Net precipitation is an indicator of the potential for leachate generation, and is equal to the difference between precipitation and evapotranspiration. Average annual evapotranspiration in Bucks County is estimated to be 27 inches per year (Sloto and Davis, 1983). Net precipitation at Willow Grove is estimated to be 18 inches, which indicates a moderate to high potential for leachate generation.

Rainfall intensity is an indicator of the potential for excessive runoff and erosion, and is of interest in determining the potential for movement of contaminants.



TABLE 3-1

CLIMATIC CONDITIONS AT
WILLOW GROVE AIR RESERVE FACILITY*
(Period of Record 1936 to 1975)

Month	TEMPERATURE (°F)			PRECIPITATION	
	Daily Maximum	Daily Minimum	Monthly Average	Normal Total (inches)	Mean Total Snowfall (inches)
January	40.1	24.4	32.3	3.16	5.3
February	42.2	25.5	33.9	3.11	6.2
March	51.2	32.5	41.9	3.52	3.7
April	63.5	42.3	52.9	3.29	0.2
May	74.1	52.3	63.2	3.34	Trace
June	83.0	61.6	72.3	3.65	-0-
July	86.8	66.7	76.8	4.10	-0-
August	84.8	64.7	74.8	4.50	-0-
September	78.4	57.8	68.1	3.41	-0-
October	67.9	46.9	57.4	2.79	Trace
November	55.5	36.9	46.2	3.10	0.7
December	43.2	27.2	35.2	3.21	4.2
YEAR	64.4°F	44.9°F	54.6°F	41.18 in.	20.3 in.

Source: Ruffner and Bair, 1977

* Data from station at Philadelphia International Airport.

The one-year, 24-hour rainfall event is used to gauge rainfall intensity. The one-year, 24-hour rainfall in the vicinity of Willow Grove is about 2.7 inches, (NOAA, 1962).

3.2 GEOGRAPHY

3.2.1 Topography

The Willow Grove Air Reserve Facility is mostly level, and slopes gently to the northwest. The highest elevation of 315 feet above mean sea level (m.s.l.) occurs along Privet Road near Building #217. The lowest elevation of 264 feet occurs in the vicinity of the basin in the northwest corner of the facility. Both the U.S. Air Force Reserve and Pennsylvania Air National Guard areas slope toward the ponding basin, (Willow Grove Air Reserve Facility, file information).

3.2.2 Soils

The principal soils on the base which have remained undisturbed by construction are the Doylestown Silt Loam, the Lawrenceville Silt Loam, the Lansdale Loam and the Readington Silt Loam (USDA, SCS, 1967). The distribution of soils is shown in Figure 3-1. Soil characteristics are summarized in Table 3-2.

Soil borings taken in 1956 prior to the construction of the facility indicate that soils and unconsolidated sediments overlying the bedrock at Willow Grove are approximately 10 feet thick at the present time, except to the south and below the parking apron and associated hangars

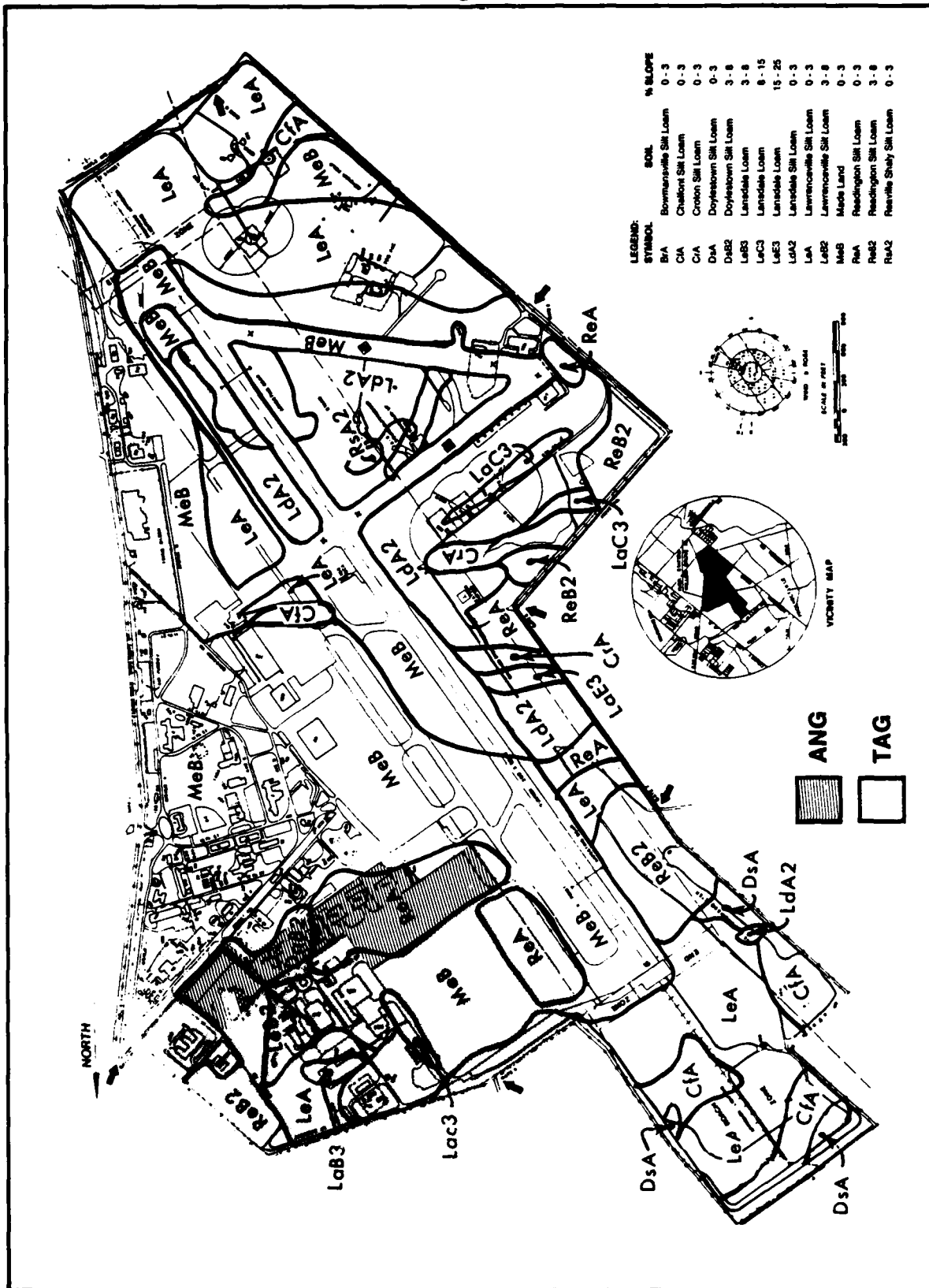


FIGURE 3-1 SOIL CONDITIONS AT WILLOW GROVE ARF

TABLE 3-2

**SOILS AT WILLOW GROVE ARF
(SOIL SURVEY - MONTGOMERY COUNTY, PENNSYLVANIA)**

Soil Name	Symbol	Permeability (in./hr.)	Depth to Seasonal High Water Table (ft.)	Depth to Bedrock (ft.)
Doylestown Silt Loam	Ds	0.63 - 6.3	0 - 0.5	4 - 8
Lansdale Loam	La	0.63 - 6.3	3+	3 - 12
Lawrenceville Silt Loam	Le	0.20 - 6.3	1 - 2	4 - 12
Readington Silt Loam	Re	0.20 - 6.3	1.5 - 2.5	3 - 5

Natural soils at the facility are members of the Lawrenceville-Chalfont-Doylestown Association. They are deep, moderately well-drained to poorly-drained soils, formed in windblown silt deposited on undulating uplands.

where structural fill has been placed to bring grade as far as 15 to 20 feet above the bedrock. The overburden is considerably more porous than the underlying bedrock.

The soil property of concern in assessing the potential for surface water infiltration is vertical permeability. The vertical permeability values for soils on the base range from 0.2 inches/hour to 6.3 inches/hour, (USDA, SCS, 1967). These values correspond to low to moderately high permeability.

3.3 SURFACE WATER RESOURCES

3.3.1 Drainage

The Willow Grove Air Reserve Facility drains generally northward into the Little Neshaminy Creek drainage basin which flows east into the Delaware River. Storm sewers and surface runoff from the U.S. Air Force and Pennsylvania Air National Guard property drain into the ponding basin, which empties into Park Creek, a tributary of Little Neshaminy Creek, at the boundary of the base. Figure 3-2 shows drainage patterns at Willow Grove ARF.

There are no streams with defined flood plains on the base property. Very localized flood conditions associated with the various man-made drainage ditches and swales exist on the base property. These flood areas can only be established through on-site observation or extensive engineering analysis, (U.S. Navy, file information). As a result, no 100-year flood plain has been delineated on the Air Reserve Facility property. However, a review of flood plain information provided in FEMA flood insurance study for Horsham

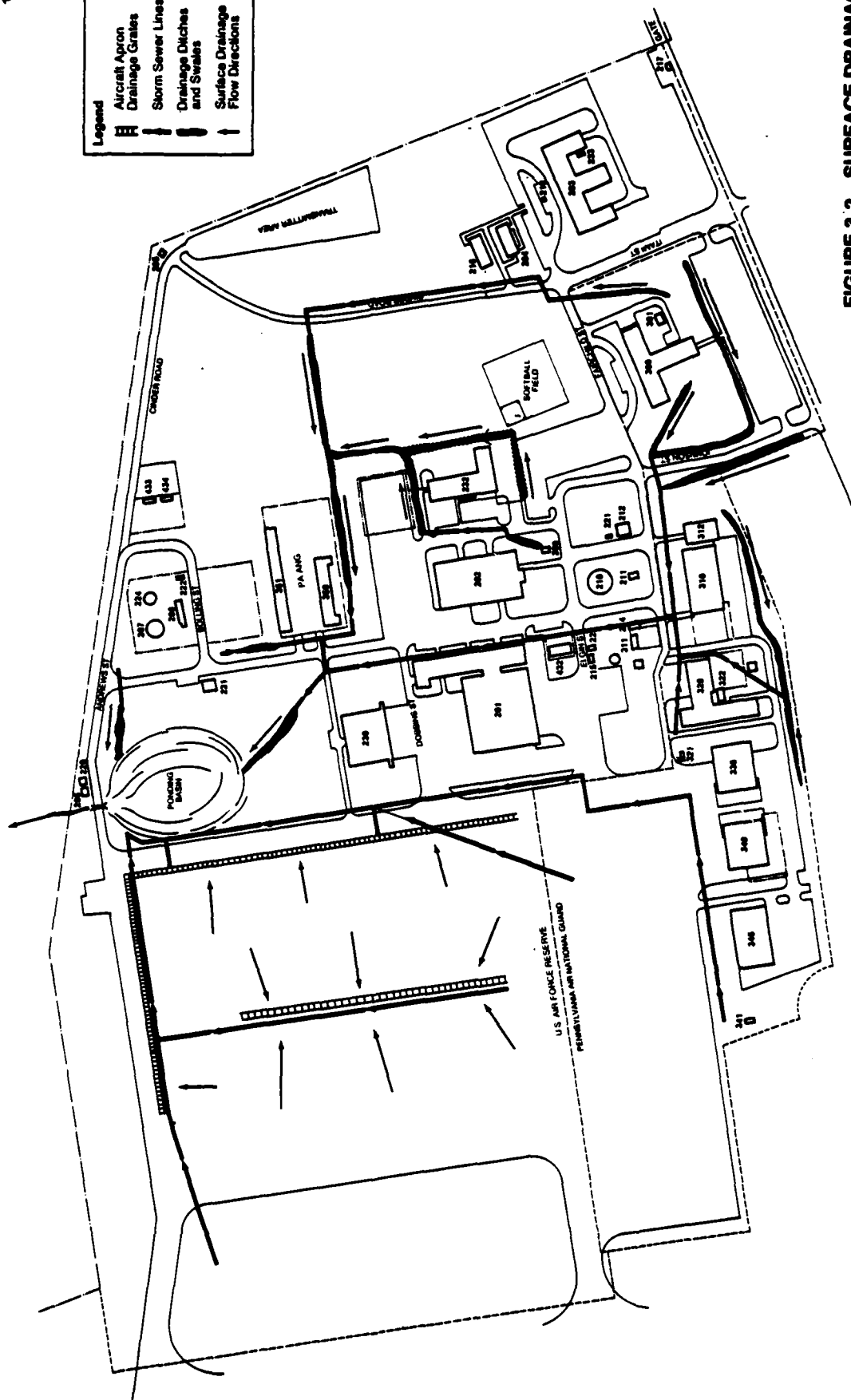
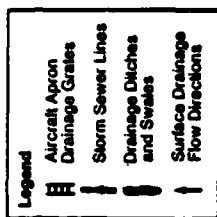


FIGURE 3-2 SURFACE DRAINAGE PATTERNS

Township indicates that the Air Reserve Facility, with the possible exception of the ponding basin, is located above the 100-year flood elevation, (FEMA, 1977). Figure 3-3 is a map of flood prone areas at Willow Grove ARF.

3.3.2 Surface Water Quality

Streamflow and water quality are not continuously recorded on Little Neshaminy Creek in the vicinity of the study area. However, water quality sampling was conducted during low flow periods in 1979 and 1980 for a study of the effects of urbanization on water resources (Sloto and Davis, 1983). The closest sampling station to Willow Grove was located on Little Neshaminy Creek at Neshaminy, approximately two miles downstream from Willow Grove. Results are summarized in Table 3-3.

The data summarized in Table 3-3 give a general picture of water quality from Willow Grove. Since the sampling was done during low flow conditions, concentrations of dissolved constituents are expected to be higher than during other periods of the year. Concentrations were also higher during the 1980 sampling period, when precipitation (and streamflow) were below average. The concentrations in samples at Station 01464800 are generally in the low to median end of the range of concentrations in samples from other streams in Warminster Township sampled during the same period. Also, samples taken further downstream in Little Neshaminy Creek show significant increases in concentrations of nutrients and other constituents. These increases are attributed to wastewater treatment plant discharges downstream from Willow Grove, and indicate that there are influences other than Willow Grove on the quality of Little Neshaminy Creek.

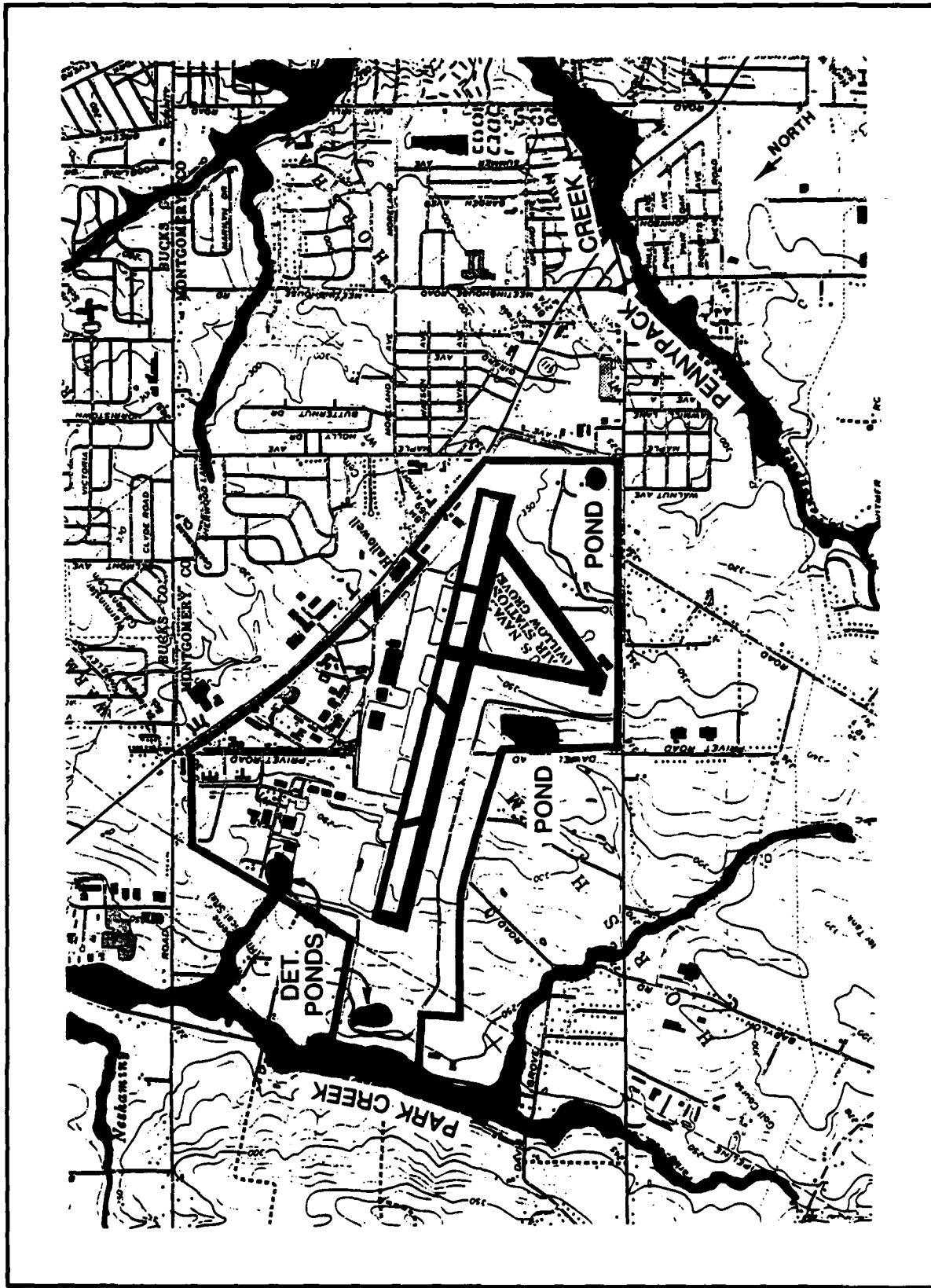


FIGURE 3-3 FLOOD-PRONE AREAS



TABLE 3-3

CHEMICAL ANALYSIS OF WATER FROM
STATION NO. 01464800
LITTLE NESHAMINY CREEK AT NESHAMINY
DURING LOW FLOW CONDITIONS

	<u>Date of Sample</u>	
	10/17/79	7/15/80
Discharge (in cubic feet per second)	29.7 cfs	1.24 cfs
Dissolved Solids, Residue at 180°C, (mg/l)	169	237
Specific Conductance (umhos)	280	370
pH	--	7.2
Temperature, °C	12.0	23.0
Calcium, Dissolved (mg/l as Ca)	22	32
Magnesium, Dissolved (mg/l as Mg)	8.0	11
Sodium, Dissolved (mg/l as Na)	15	21
Sodium and Potassium, Dissolved (mg/l as Na)	17	--
Potassium, Dissolved (mg/l as K)	2.1	3.1
Chloride, Dissolved (mg/l as Cl)	19	31
Sulfate, Dissolved (mg/l as SO ₄)	36	41
Nitrogen, Nitrate Dissolved (mg/l as N)	2.20	1.20

TABLE 3-3
(Con't)

CHEMICAL ANALYSIS OF WATER FROM
STATION NO. 01464800
LITTLE NESHAMINY CREEK AT NESHAMINY
DURING LOW FLOW CONDITIONS

	<u>Date of Sample</u>	
	10/17/79	7/15/80
Nitrogen, Nitrite, Dissolved (mg/l as N)	.000	.040
Phosphorous, Ortho, Dissolved (mg/l as P)	.050	.340
Phosphorous, Dissolved (mg/l as P)	.090	.340
Iron, Dissolved (ug/l as Fe)	60	20
Manganese, Dissolved (ug/l as Mn)	60	230
Silica, Dissolved (mg/l as SiO ₂)	14	8.4
Fluoride, Dissolved (mg/l as F)	.2	.6
Carbon, Organic, Dissolved (mg/l as C)	2.9	--
Alkalinity, Field (mg/l as CaCO ₃)	41	83
Hardness (mg/l as CaCO ₃)	88	130
Hardness, Noncarbonate (mg/l as CaCO ₃)	47	42
Cadmium, Dissolved (ug/l as Cd)	1	4



TABLE 3-3
(Con't)

CHEMICAL ANALYSIS OF WATER FROM
STATION NO. 01464800
LITTLE NESHAMINY CREEK AT NESHAMINY
DURING LOW FLOW CONDITIONS

	<u>Date of Sample</u>	
	10/17/79	7/15/80
Chromium, Dissolved (ug/l as Cr)	< 10	20
Copper, Dissolved (ug/l as Cu)	2	6
Lead, Dissolved (ug/l as Pb)	0	1
Mercury, Dissolved (ug/l as Hg)	.2	.1
Selenium, Dissolved (ug/l as Se)	--	0
Zinc, Dissolved (ug/l as Zn)	--	4

Source: Sloto and Davis, 1983

The protected use for Little Neshaminy Creek basin is warm water fishes: "maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat", (PA DER, 1980).

Water quality criteria have been developed for the warm water fish use classification. The concentrations reported in Table 3-3 are less than the maximum values for which primary and secondary drinking water standards have been established.

3.3.3 Surface Water Use

Surface water uses in the vicinity of Willow Grove are related primarily to water supply and wastewater treatment. The majority of water supplies in the vicinity of Willow Grove are obtained from groundwater aquifer. An exception is a surface water intake for a municipal supply near the confluence of the Little Neshaminy Creek and Delaware River, located 10 miles downstream from Willow Grove ARF. The creek is also used for disposal of treated wastewater effluents by a number of municipalities downstream of Willow Grove ARF.

3.4 GROUNDWATER RESOURCES

3.4.1 Background Geology

Willow Grove ARF overlies a major regional bedrock water supply aquifer. This subsection describes the geologic setting of the facility, the underlying hydrogeologic units and their characteristics, regional groundwater quality, and groundwater use.

Willow Grove is situated in the southern portion of the Triassic Basin, and is underlain by the Stockton Formation, which consists primarily of gray and red sandstone with red shale interlayers and has a total thickness of 6,000 feet near the Bucks-Montgomery County line (Rima and Others, 1962). Three members are distinguished within the Stockton: the lower arkose member, characterized by abundant coarse-grained arkosic sandstone and arkosic conglomerate (composed of unsorted quartz and feldspar grains); the middle arkose member, characterized by abundant fine- and medium-grained arkosic sandstone; and the upper shale member, characterized by abundant shale and siltstone. The middle arkose member, which underlies Willow Grove ARF and most of Warminster Township, has a maximum thickness of 4,200 feet at the Bucks-Montgomery County line, and makes up 70% of the Stockton Formation. The middle arkose member has the best water yield of the formations.

Individual lithologic units in the Stockton vary from 10 to 120 feet in thickness, and show great lateral variability in texture, pinching out or grading laterally into beds of different grain size or color, (Rima and Others, 1962; Sloto and Davis, 1983). Vertical jointing is well developed regionally. A geologic map is presented in Figure 3-4.

3.4.2 Hydrogeologic Conditions

The Stockton Formation underlying the ARF is the major aquifer (or water-yielding subsurface hydrogeologic unit) in the region. Groundwater flow in the Stockton occurs primarily through fractures in the rock, and is, therefore, strongly influenced by the size, frequency,

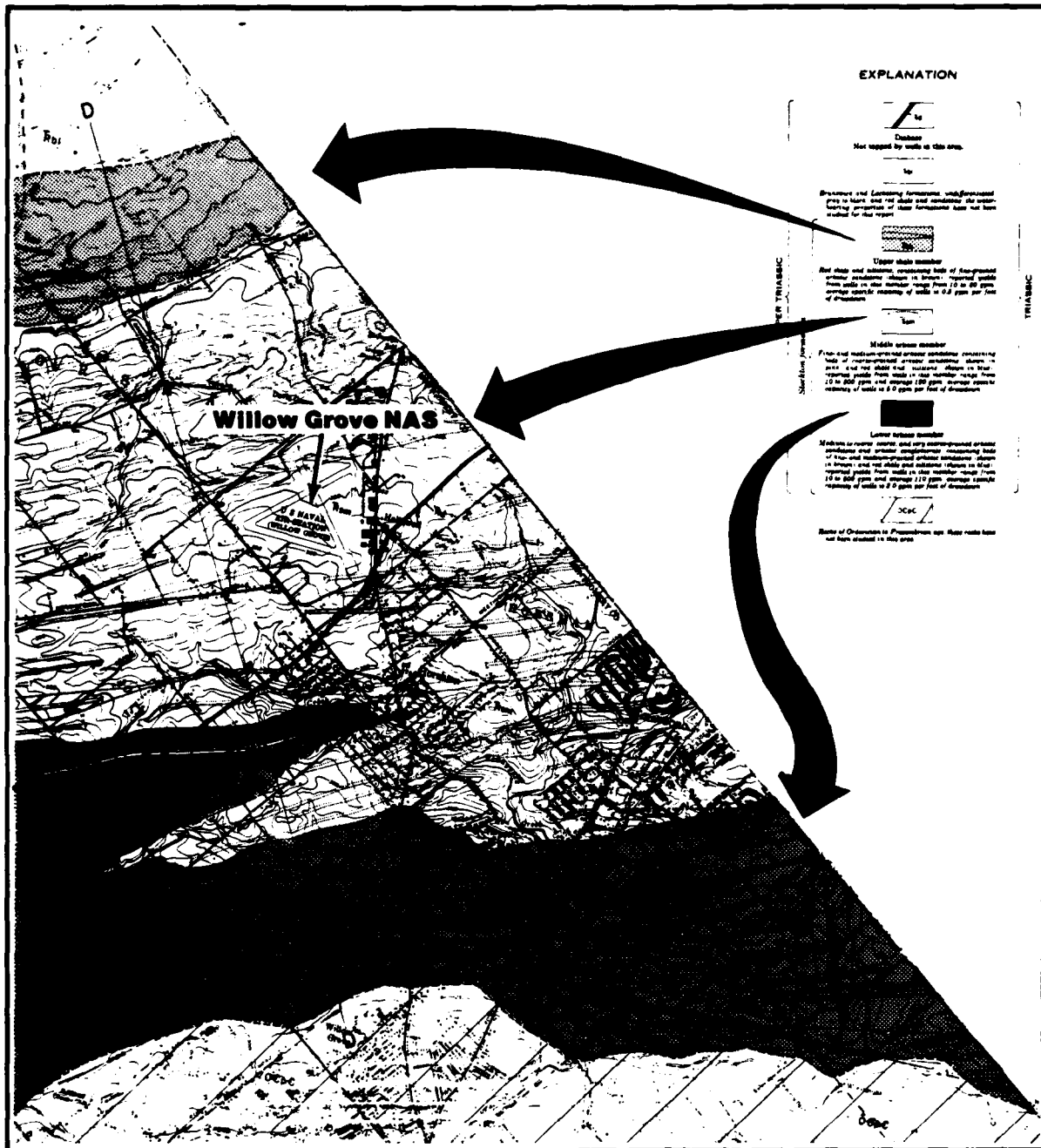


FIGURE 3-4 GEOLOGIC MAP OF THE STOCKTON FORMATION IN THE VICINITY OF WILLOW GROVE ARF AND WILLOW GROVE NAS

distribution and orientation of fractures and fracture zones. Most deep wells in the region draw water from several major fracture zones, and the hydraulic head in each zone generally varies (Sloto and Davis, 1983). The static water level in a well, therefore, reflects the composite hydraulic head of the different water-yielding zones which it penetrates. Water wells in the region are seldom drilled below a depth of 500 feet because the water-bearing capacity of bedrock decreases with depth.

According to Sloto and Davis (1983), yields of drilled wells in the area range from 8 to 700 gallons-per-minute (gpm) with a median of 145 gpm. Rima and Others (1962) reported values of transmissivity ranging from 8,000 to 23,000 gallons-per-day-per-foot (gpd/ft.) for the Stockton in the area of Doylestown and Langhorne based on pumping tests performed in 1957 to 1958. Based on pumping tests performed in 1979 to 1980, Sloto and Davis (1983) reported that production wells pumped at 235 to 309 gpm for 48 to 71 hours, caused drawdown to occur in observation wells downdip, updip or along strike, as far away as 2500 feet, even if the wells did not penetrate the same stratigraphic intervals. Transmissivity values derived from these tests were not reported.

The Stockton is overlain throughout the area by a relatively thin (2 to 15 feet) cover of soil and unconsolidated sediment formed primarily from in situ chemical and mechanical weathering of the bedrock, and grading downward to less and less weathered bedrock. The bedrock surface elevation below Willow Grove ARF has been well-defined by a series of soil borings made in 1956 prior to facility construction and during subsequent development. Logs for these borings are available

for the Civil Engineer's office. They indicate that subsurface materials below Willow Grove ARF consist of brown clay, silty sandy clay, and sandy clay grading downward to weathered shale. Bedrock near the surface consists of medium hard sandstone, brown and reddish brown, overlain in many places by 3 to 20 feet of soft to medium hard red shale, usually decomposed by weathering.

Data from these borings have been used to compile the bedrock surface map in Figure 3-5. According to this map, the bedrock slopes gently downward to the north, approximately downdip and paralleling the original topography from an elevation of 290 feet mean sea level (m.s.l.) along Privet Road on the southeast boundary of the ARF to 270 feet along the northern boundary. A low point on the bedrock surface (elevation 260 feet) occurs at the current site of the ponding basin.

The unconsolidated overburden is considerably more porous than the underlying fractured bedrock, and generally acts as a storage medium for wet season infiltration which is slowly transmitted as recharge to the bedrock aquifer. The overburden is generally in good hydraulic communication with the upper, weathered bedrock zone, and together they form the upper, water table aquifer, in which water pressure is in equilibrium with atmospheric. The water table rises during the wet season (November to April) as infiltration moves through the soil down to the saturated zone, where all void spaces are filled with water. In the spring and summer, evapotranspiration from soil and plants takes up water before it can reach the saturated zone, and even draws water from the saturated zone, causing the water table

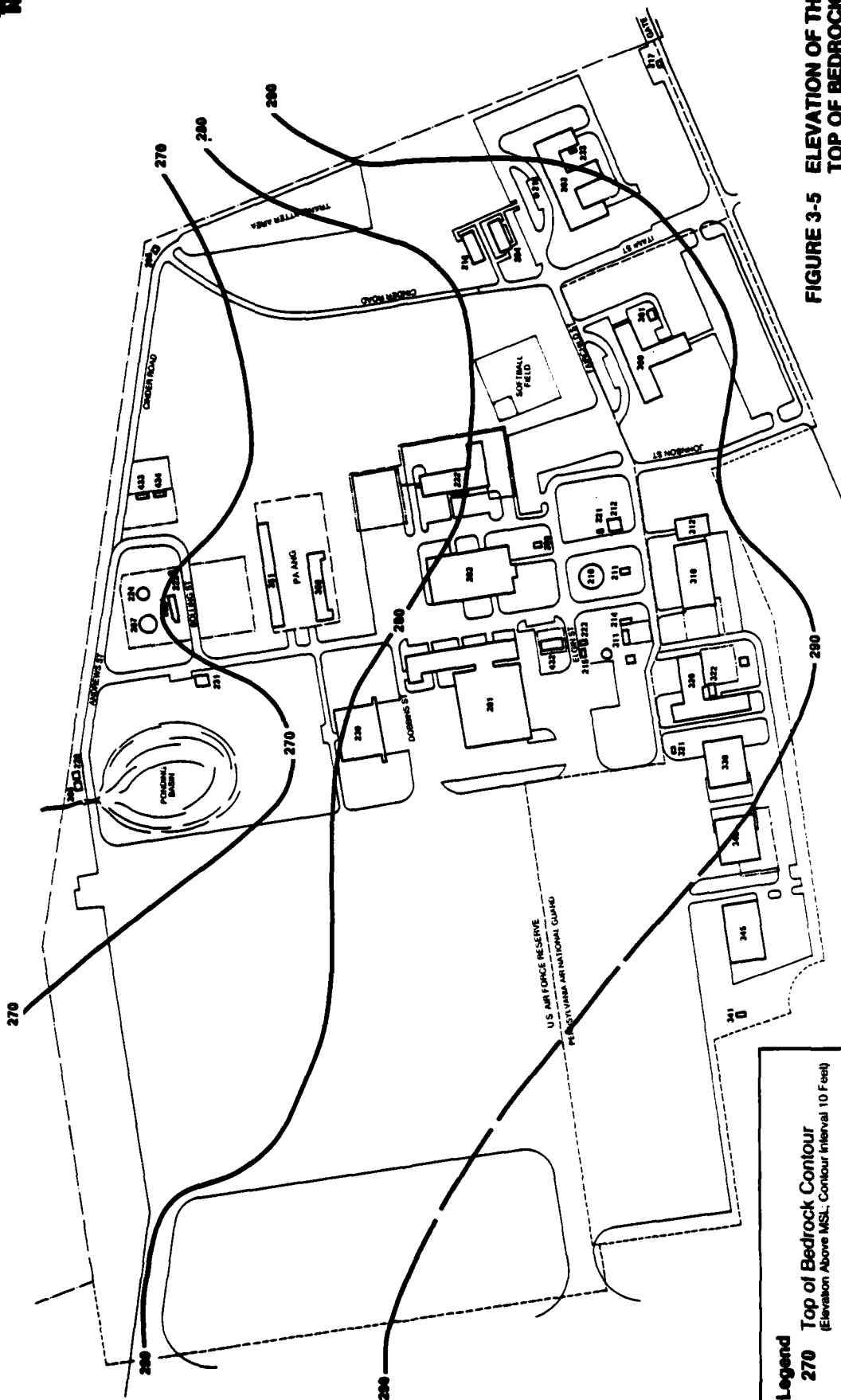


FIGURE 3-5 ELEVATION OF THE TOP OF BEDROCK BENEATH WILLOW GROVE ARF

Legend
270 Top of Bedrock Contour
 (Elevation Above MSL, Contour Interval 10 Feet)
 Source: Base Civil Engineering Drawings, October 31, 1956

to fall. The height of the water table determines the hydraulic head and the driving force downward into the bedrock aquifer and laterally into shallow streams and ditches incised into the overburden. When the water table is high, the recharge rate to the bedrock aquifer increases, as does the baseflow in streams and spring-flow in hillside groundwater springs, which usually occur at the overburden-bedrock interface. As the water table falls, recharge decreases and spring- and stream-flow may decrease or cease. The water table aquifer dries up locally in the summer in areas which have only a relatively thin overburden and/or are heavily influenced by nearby pumping from the bedrock aquifer.

This seasonal pattern has a significant influence on the directions and rates of contaminant migration in the subsurface. In areas of Bucks and Montgomery counties where surface spills of contaminants have been known to occur, groundwater in the saturated overburden is commonly found to exhibit concentrations of the contaminants of interest several orders of magnitude higher than groundwater in the underlying bedrock aquifer. Furthermore, concentrations in the overburden are found to vary seasonally, often increasing in the spring as additional contaminants are carried down to the saturated zone from the surface soil by infiltration. At the same time, baseflow to streams may exhibit high concentrations due to contributions from the water table aquifer. Due to the restricted saturated thickness of the water table aquifer and its sometimes ephemeral nature, it is extremely difficult to effectively recover contaminated groundwater directly from this zone.

A rough water table map for the ARF in October 1956 (Figure 3-6) has been constructed from water level data available from the same boring logs used in Figure 3-5. According to this map, the water table at this time roughly paralleled bedrock surface and was almost coincident with it over much of the facility area, particularly to the north. Along the southeast boundary, the water table was 5.6 feet higher than bedrock surface. Two apparent "valleys" in the water table map indicate directions of concentrated groundwater flow or discharge along topographic stream valleys, with the major one flowing through the area of the current ponding basin. Based on this information, the water table aquifer underlying the site can be assumed to be quite shallow, on the order of 2 to 8 feet thick, and probably ephemeral. Although there are no current groundwater level measurements available for the facility, the present water table can be assumed to be strongly influenced by pumping from the Air Force supply well (AF-I) and nearby Navy wells (NAS-1 and NAS-2).

3.4.3 Groundwater Quality

3.4.3.1 Natural Groundwater Quality

Water quality analyses for 15 wells in the Stockton Formation were selected from the U.S. Geological Survey Chemistry Data Base by REWAI (1982) as representative of background groundwater quality for that formation. A statistical summary of inorganic parameters in these wells is presented in Table 3-4, and is compared with a similar summary for analysis of 55 wells samples from the Stockton reported by Rima and Others (1962).

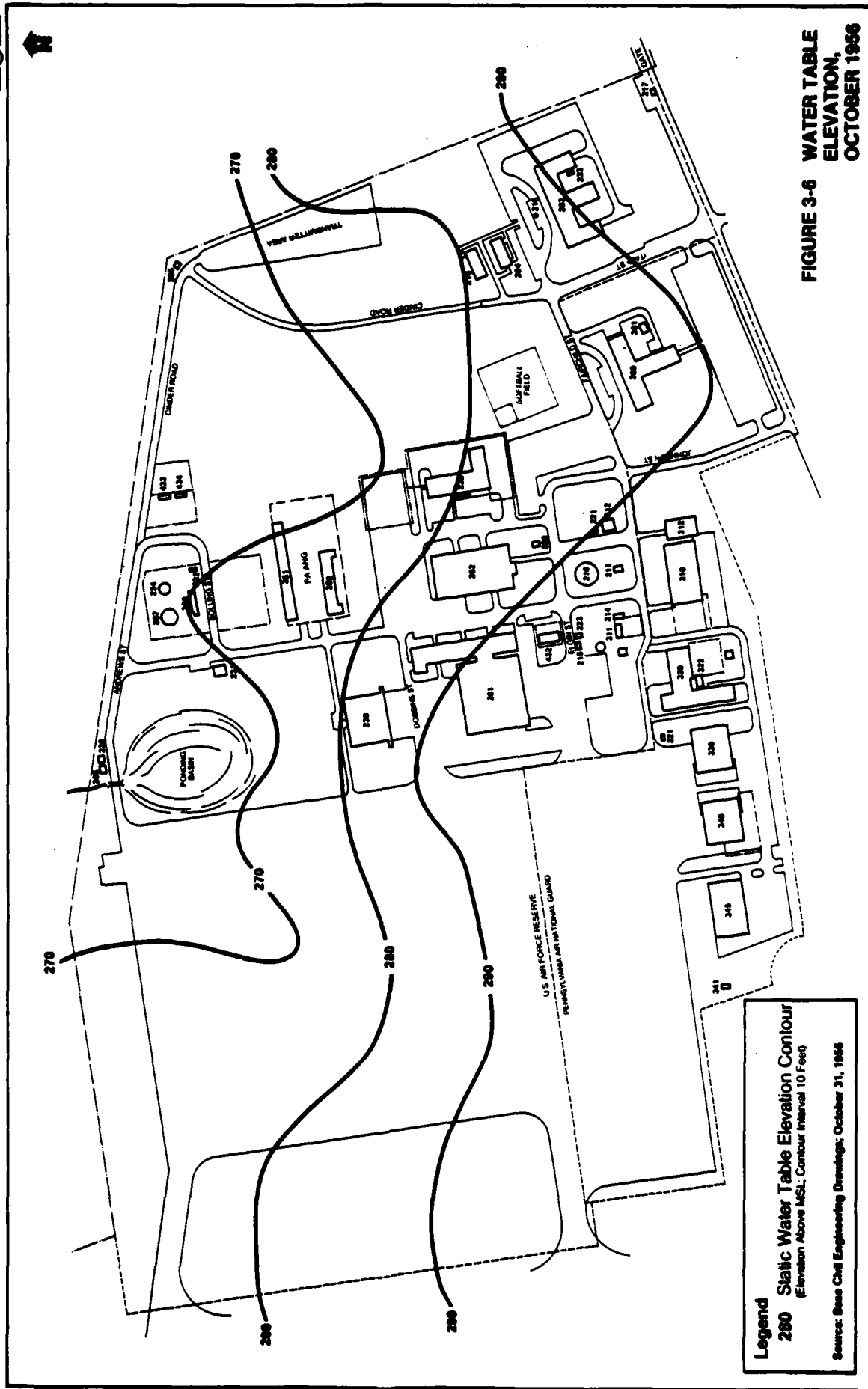


TABLE 3-4

**STATISTICAL SUMMARY OF BACKGROUND GROUNDWATER
QUALITY IN THE STOCKTON FORMATION (1)**

Parameters	REWAI (1982) 5-15 Wells		Rima & Others (1962) 13-56 Wells	
	Range	Median	Range	Median
pH	5.2-8.1	7.2	6.2-8.5	7.8
Specific Conductance (umhos/cm)	95-397	255	69-1230	317
Nitrate-NO ₃ (mg/L)	1.1-278	10	0.0-10.7	1.6
Chloride (mg/L)	5.5-26	9.5	1.2-80.0	8.6
Sulfate (mg/L)	15-350	24	8.4-725.0	28.0
Sodium (mg/L)	8.1-87	8.2	6.8-21.0	12.0
Iron (mg/L)	<0.01-1.2	0.10	0.02-1.3	0.16
Manganese (mg/L)	<0.01-0.80	0.04		
Hardness (mg/L)	18-450	100		
Bicarbonate (mg/L)	7-188	84		
Total Dissolved Solids (mg/L)	120-872	152		

Reference

(1) REWAI (1982), p. 8-17, 18, 25

Based on this table, groundwater in the Stockton is moderately hard, moderately mineralized, and generally has a neutral pH. A few of the wells sampled exhibited elevated levels of iron and manganese, but median values for these parameters are below the EPA-recommended secondary drinking water standards of 0.3 and 0.05 mg/l respectively. High sulfate concentrations (up to 460 mg/l) are locally encountered in the Stockton. They are generally associated with elevated calcium levels, presumably from dissolution of natural calcium sulfate minerals in the rocks (Sloto and Davis, 1983). However, no correlation has been found between sulfate concentration and geographic distribution, topographic, well depth, or the presence of a diabase dike. In most cases, natural water quality in the Stockton meets all requirements for a drinking water supply.

3.4.3.2 Regional Groundwater Quality

Incidents of groundwater quality degradation from contamination, primarily with synthetic organic chemicals, have been well documented in Warminster and surrounding areas.

Table 3-5 lists maximum reported concentrations of volatile organic compounds found in groundwater in the Warminster area. The primary contaminants of concern are trichloroethylene (TCE) and tetrachloroethylene (PCE). Table 3-6 lists the concentrations of TCE and PCE in samples taken from wells at Willow Grove ARF. As shown in the tables, the concentrations detected at Willow Grove are significantly lower than found elsewhere in the region. TCE and PCE are solvents, commonly used as metal degreasers, dry cleaning

**MAXIMUM REPORTED CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER (1)**

Compound	Maximum Reported Concentration (ug/L) (PPb))
Benzene	2
Bromodichloromethane	240
Bromoform	250
Carbon tetrachloride	50
Chlorobenzene	500
Chloroform	500
p Dichlorobenzene	0.1
1,1-Dichloroethane	24
1,2-Dichloroethane	370
1,1-Dichloroethylene	660
cis-1,2-Dichloroethylene	11,000
trans-1,2-Dichloroethylene	51
1,2-Dichloropropane	250
trans-1,3-Dichloropropylene	4.7
Methyl chloride	9.3
Tetrachloroethane	2.6
Tetrachloroethylene (PCE)	26,000
1,1,1-Trichloroethane	900
Trichloroethylene (TCE)	87,000

Reference:

- (1) Sloto and Davis, 1983. Data provided by the
U.S. Environmental Protection Agency



TABLE 3-6

RANGES OF TCE AND PCE CONCENTRATIONS IN
WILLOW GROVE NAVAL AIR STATION SUPPLY WELLS
OCTOBER 1979 THROUGH JUNE 1984

Well Name	Concentration	
	TCE (ug/L) (ppb)	PCE (ug/L) (ppb)
NAS-1	2.0 to 38.4	1.1 to 68.8
NAS-2	2.3 to 42.4	1.2 to 30.8
AF-1	0.1 to 23.7	1.9 to 9.4

products, and septic tank cleaners. They are known to have reached groundwater from leaking storage tanks, spills, and improper handling and disposal methods.

TCE and PCE are related halogenated hydrocarbons, commonly found together. Both are stable, mobile, and only slightly soluble in water. Their molecules are heavier than water and tend to move downward in aquifers. Both are confirmed animal carcinogens and affect the human central nervous system, causing depression, dizziness, and fatigue at high concentrations (Council on Environmental Quality, 1981). Sloto and Davis (1983) described the development of concern over groundwater contamination with TCE and PCE, and subsequent effects on public water supplies in the Warminster area as follows:

In 1979, some wells in central Montgomery County were found to be contaminated by trichloroethylene as the result of industrial spills. Public water suppliers in southeastern Pennsylvania began testing for and finding volatile organic compounds in well water. In September 1979, the Warminster Municipal Authority removed two wells from service, and the Upper Southampton Authority removed three wells from service because of trichloroethylene and tetrachloroethylene contamination. The Hatboro Water Authority removed five wells from service in October and one in November. In October, the Warminster Heights Development Corporation found volatile organic compounds in both of their wells, and the Warrington Water Company removed two of their four wells from service because of trichloroethylene contamination. In October, the Environmental Protection Agency (EPA) began testing municipal, industrial, and domestic wells for volatile organic contamination. In November, the U.S. Naval Air Development Center removed three wells from service. The Horsham Township Authority removed one well from service in January 1980 and another in April 1980. The locations of wells sampled for trichloroethylene



and tetrachloroethylene are shown in Figure 20. Data were provided by the Bucks County Health Department, EPA, and municipal water authorities.

Through an aggressive sampling and enforcement program, the EPA, Pennsylvania Department of Environmental Resources (PA DER) and the county health departments have succeeded in identifying several major industrial sources of TCE and PCE in the area, and remedial measures have been undertaken at some sites. However, contamination with TCE and PCE remains widespread. At Willow Grove Naval Air Station, TCE and PCE concentrations are measured monthly in all three production wells, and production rates are adjusted to bring the combined effluent concentration below the EPA recommended limit of 4.5 ug/L for drinking water. Ranges for TCE and PCE concentrations in the three wells, including AF-1, the well on the Willow Grove ARF, are listed in Table 3-6.

A contract has recently (June 1984) been awarded by the U.S. Navy to Earth Data, Inc. of West Chester, Pennsylvania for a complete hydrogeologic investigation of the Willow Grove NAS facility including location of nearby sources of TCE and PCE, and a treatability study to develop an adequate and cost-effective treatment alternative for water supply at the facility.

In addition to contamination with volatile organic compounds, there has been relatively localized groundwater contamination in the area with other organics, particularly hydrocarbons spilled or leaking from storage tanks. Among inorganic parameters, iron, manganese and sulfate are locally found at elevated concentrations, but these are generally attributable to natural sources. Both REWAI (1982) and Sloto and Davis (1983) indicated a widespread increase in nitrate levels in groundwater since the 1950's, probably attributable to contamination in rural areas from application of

nitrogen fertilizers and use of on-lot sewerage systems. Sloto and Davis (1983) noted that lead concentrations in 26 wells sampled in the Warminster area in 1979 to 1981 ranged from 0 to 55 ug/L, with a median of 17 ug/L. Although only one sample exceeded the EPA National Interim Primary Drinking Water Standard of 50 ug/L, the median was higher than reported nearby and national medians. They attributed this to the urbanized character of the area, and the widespread occurrence of lead presence as a component of automobile exhaust. Eleven inorganic parameters are sampled for quarterly in the base supply wells. The result from the May 1983 analysis are given in Table 3-7. All concentrations measured are well below EPA recommended drinking water standards. The locations of the wells are shown in Figure 3-7.

3.4.4 Groundwater Use

3.4.4.1 On-Base Wells

The Willow Grove Naval Air Station (NAS) and Air Reserve Facility (ARF) are supplied by a dual water distribution system drawing water from three wells: two on NAS property (NAS-1 and NAS-2), and one on ARF property (AF-1). A fourth well (AF-2) was drilled at the same time as AF-1 and was the principal ARF supply well in the late 1950's. Its use was discontinued due to excessive hardness of the well water, and AF-1 became the principal supply well for the ARF. Locations of the base supply wells are shown in Figure 3-7. Well specifications for which records were available are given in Table 3-8.



TABLE 3-7

INORGANIC PARAMETER CONCENTRATIONS
IN WILLOW GROVE AIR STATION SUPPLY WELLS -
MAY 9, 1983

Parameters	Concentration ug/L		
	AF-1	NAS-1	NAS-2
F1	0.12	0.17	0.13
NO ₃ -N	1.3	0.16	0.65
As	0.0032	0.0082	0.0039
Ba	0.29	0.15	0.22
Cd	<0.0001	<0.0001	<0.0001
Cr	0.0014	<0.001	0.0016
Pb	<0.001	<0.001	0.0018
Hg	<0.0002	<0.0002	<0.0002
Sc	<0.002	<0.002	<0.002
Ag	<0.0002	<0.0002	<0.0002
Na	10.9	10.6	11.3

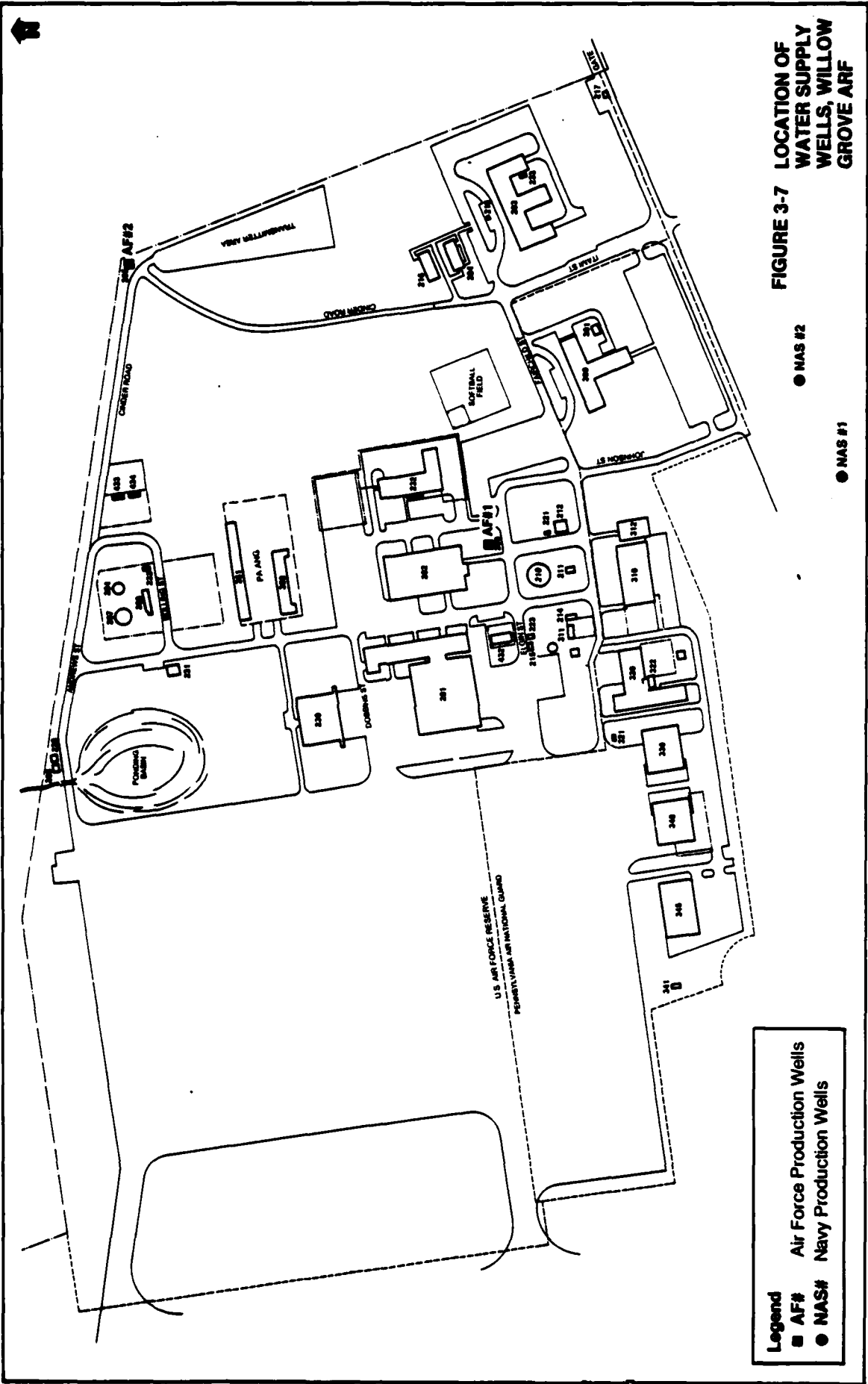


TABLE 3-8

SUPPLY WELL SPECIFICATIONS
WILLOW GROVE NAVAL AIR STATION

Well Name	USGS No.	Well Driller	Year Comp.	Total Depth Below G.S. (feet)	Casing Diameter (inches)	Cased Interval Below G.S. (feet)	Nominal Yield (gpm)	Static Water Level Below G.S. (feet)	Static Water Level Below G.S. (feet)
NAS-1	MG-209	F.L.Bollinger & Sons	1942	397	10	0 to 52	100	8	55
NAS-2	MG-210	F.L.Bollinger & Sons	1942	351	10	0 to 43	180	14	110
AF-1	MG-489	Phila. Drlg. Co.	1957	350	10	—	300	—	—
AF-2 (out of use)	MG-490	Phila. Drlg. Co.	1957	330	10	—	360	—	—

References:

1. REWAI, 1982
2. Sloto and Davis, 1983

The ARF and NAS water supply systems were originally operated independently, and have a single tie-in line connecting the two systems. Since concern over TCE and PCE concentrations in well water developed in 1979, the wells have been operated as a combined system, with production rates for each well assigned on the basis of well yield and measured contamination levels. The combined nominal yield of the three supply wells is 580 gallons per minute (gpm). In general, TCE and PCE concentrations have remained lower in AF-1 than in NAS-1 and NAS-2 (Table 3-6). For this reason, AF-1 is currently being used preferentially over the other two. At the time of the site visit (June 25 to 29, 1984), AF-1 was being used exclusively to supply both NAS and ARF, at an average rate of 210 gpm for 18 hours per day, or 0.227 million gallons per day (mgd).

3.4.4.2 Regional Groundwater Use

According to Sloto and Davis (1983, p. 8) "all the municipal authorities, private water suppliers, industries, and government facilities [in the Warminster area] obtain their water supply from wells". Table 3-9 lists groundwater pumpage in 1980 for major users in the area. In addition, Sloto and Davis (1983) estimate about 25 million gallons were pumped by domestic and small commercial and industrial users.

Both total groundwater use and per capita use increased as the population grew. Between 1960 and 1980, Warminster Township experienced a 122% increase in population. During the same period, groundwater pumpage increased 755% to 1.06 billion gallons per year and per capita use increased 290% to 82 gpd per person.



TABLE 3-9

GROUNDWATER PUMPAGE IN 1980 BY
PUBLIC WATER SUPPLIERS & GOVERNMENT FACILITIES

	Number of Wells	Groundwater Pumpage (million gals.)
Hatboro Water Authority	10	571.7
Horsham Township Authority	13	386.7
Northampton Municipal Authority	5	205.3
Warminster Heights Development Corp.	2	66.5
Warminster Municipal Authority	14	1,063.4
Warrington Municipal Authority	2	106.0
Warrington Water Company	2	3.3
U.S. Naval Air Development Center	3	65.4
U.S. Naval Air Station	3	108.6
Upper Southampton Municipal Authority	<u>4</u>	<u>142.6</u>
TOTALS	58	2,719.5

Groundwater use in the Warminster area falls under the jurisdiction of the Delaware River Basin Commission (DRBC), a regulatory body created in 1961 and including representatives of Delaware, New Jersey, New York and Pennsylvania. The DRBC has the authority to resolve disputes concerning water supplies and water resources management between these states with the Delaware River Basin. It permits withdrawal from and discharge into surface water bodies within the basin, and groundwater withdrawals exceeding 100,000 gpd. It also reviews and approves industrial wastewater discharges to groundwater, land use changes in groundwater recharge areas, and dewatering and filling of wetlands (REWAI, 1982). In 1980, the DRBC designated portions of southeastern Pennsylvania including Warminster Township as groundwater protected areas, due to high demands on groundwater supplies aggravated by the drought of 1980 to 1981. In these areas, groundwater allocation permits are required for all new groundwater uses averaging more than 10,000 gpd. Permit requirements include advance notification of drilling, report on a detailed pumping test including impact on adjacent water supplies and streamflow, and description of conservation and emergency plans.

3.5 BIOTIC ENVIRONMENT

Development has destroyed most of the natural vegetation, particularly trees and large shrubs, in the vicinity of Willow Grove. The variety, distribution and abundance of wildlife is determined primarily by habitat, food availability and proximity to man. The remaining habitat in the area supports a diversity of

mammals due to the availability of edge habitat created by the proximity of cultivated fields, woodlands, wetlands, old fields, streams and ponds (U.S. Navy, file information).

According to the U.S. Department of Agriculture, wildlife species normally found in cropped fields, pastures, meadows, lawns and areas overgrown with weeds, grass and shrubs in Montgomery County include quail, pheasant, morning doves, meadowlarks, rabbit, red fox and groundhog. Species normally found in wooded area are ruffed grouse, wild turkey, deer, squirrel, raccoon, wood thrushes, warblers, and vireos. Non-game species of birds, such as songbirds, are also numerous. A variety of waterfowl species inhabit wet areas, such as swamps, marshes and ponds (USDA, 1967).

3.6 SENSITIVE ENVIRONMENTAL FEATURES

There are no known threatened or endangered species at Willow Grove, ARF. The peregrine falcon, which is recognized as endangered or threatened on the federal endangered species list, has been recorded in the local area, but is a rare transient during the period of March to November (U.S. Navy, file information).

The Graeme Historical Site is located approximately one mile northwest of the Willow Grove ARF. The historical site is downstream from the Willow Grove ponding basin. Discharges from Willow Grove ARF flow through a duck pond on the property of the historic site, via Park Creek.

3.7

SUMMARY OF ENVIRONMENTAL CONDITIONS AT WILLOW GROVE ARF

The following environmental conditions are of particular importance in the evaluation of past hazardous waste disposal practices at Willow Grove ARF:

1. The mean annual precipitation is 41 inches, the net precipitation is 18 inches and the one-year, 24-hour rainfall event is estimated to be 2.7 inches. These data indicate there is moderate to high potential for infiltration into the surface soils on the base, and that there is moderate to high potential for runoff and erosion.
2. The natural soils on the base are loams and silt loams. Soil permeabilities range from 0.2 to 6.3 inches per hour, which correspond to slow to moderately rapid permeability. Soils data indicate that recharge of infiltration through the soil will be slow to moderately rapid. The soils and other consolidated material overlying the bedrock are considerably more porous than the bedrock.
3. Surface water is controlled on base by open ditches, and underground storm sewers. There are no natural surface water features on the base. No 100-year flood plain has been delineated on the base, but highly localized flooding does occur.
4. Bedrock in the vicinity of Willow Grove is the Stockton Formation, which consists primarily of gray and red sandstone with interlayers of red

shale. The Stockton formation lies approximately 10 feet below the surface at Willow Grove, and as far as 15 to 20 feet below the surface in areas where structural fill has been placed.

5. Groundwater is an important resource in the vicinity of Willow Grove. The Stockton formation, the bedrock aquifer, is an important source of private and public water supplies. The water table in the unconsolidated upper aquifer fluctuates seasonally. This fluctuation would have a significant influence on the direction and rate of contaminant migration in both the unconsolidated and bedrock aquifers, because primary source of recharge for the bedrock aquifer is the unconsolidated aquifer.
6. There are no known federal endangered or threatened species which inhabit the area.

SECTION 4**FINDINGS****4.1 INTRODUCTION**

This section presents information on the 913th TAG of the U.S. Air Force Reserve, and the Pennsylvania Air National Guard (111th PaANG) activities at Willow Grove Air Reserve Facility. The information describes past and present activities which have resulted in the generation, storage and disposal of industrial wastes; identifies fuel spill sites located on the base; and summarizes industrial waste disposal methods.

This section is organized to describe the individual practices and environmental concerns at each facility separately. Information included in this section was obtained primarily from interviews with current and former base employees, a review of files and records, and site inspections.

4.2 913th TACTICAL AIR GROUP**4.2.1 Overview of Industrial Operations**

Industrial activities conducted by the 913th TAG at Willow Grove ARF can be grouped into three broad categories: 1) Aircraft Maintenance, 2) Base Civil Engineering, and 3) Fuel Operations. Each of these

operations occur in several different shops and spaces at Willow Grove ARF.

This subsection provides an overview description of the major activities that occur under each of these three major categories. Shop by shop descriptions and specific wastes generated will be presented in a subsequent subsection of this report. Figure 4-1 shows all major buildings and facilities at Willow Grove ARF.

Aircraft Maintenance

Most aircraft maintenance operations occur in Building #201 which is the main aircraft maintenance hangar for the 913th TAG. Several shops are located in this facility, including a machine shop, sheet metal shop, welding shop, pneudraulics systems shop, repair and reclamation shop, corrosion control shop, aircraft washing facilities, as well as other facilities, which will be presented in more detail in a subsequent section.

These shops perform the full spectrum of repair and maintenance activities on the C-130 aircraft and ground support equipment owned by the 913th TAG.

Typical chemicals and hazardous materials handled in these facilities are oils, solvents, batteries and contaminated fuels. Most wastes generated are accumulated by Base Supply for eventual pickup by DPDO Philadelphia. Some liquid wastes, such as battery acid, are diluted and neutralized, and drained to the sanitary sewage system.

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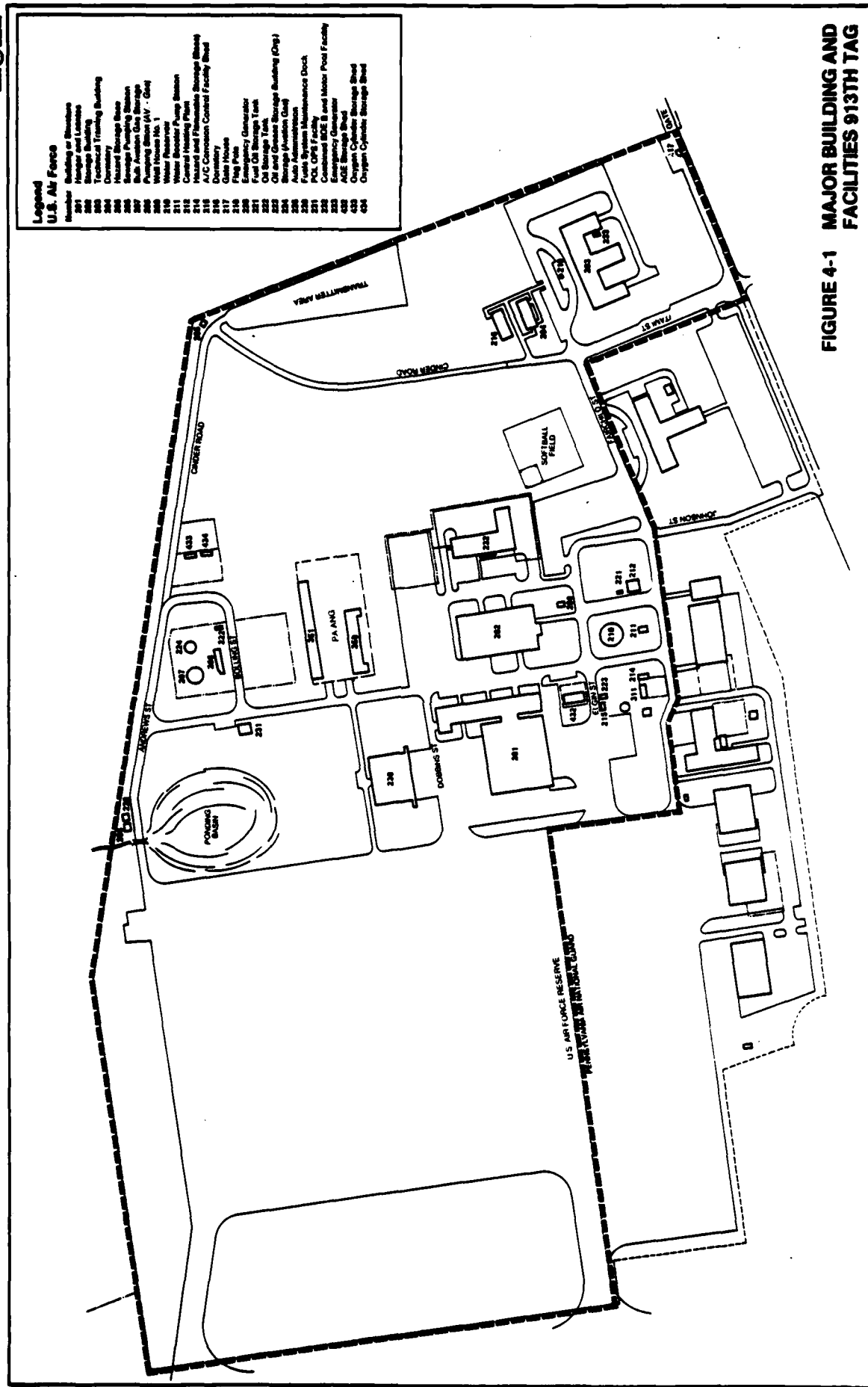


FIGURE 4-1 MAJOR BUILDING AND FACILITIES 913TH TAG



There are no dumps or landfills at Willow Grove ARF. However, in the past some hazardous wastes from Willow Grove ARF have been disposed of in a dump which is owned and operated by the U.S. Navy. This Navy dump is located on Navy property and has not accepted hazardous wastes since 1980.

Base Civil Engineering

Most industrial operations under Base Civil Engineering occur in Building #232. Shops include a paint shop, plumbing shop, carpenter shop, flammable materials storage facilities. Solvents, oils and paints generated by these facilities are accumulated by Base Supply for eventual pick-up by DPDO Philadelphia.

Other wastes such as grease and oily wastes from oil water separators are disposed of off-site by contract disposal. Base Civil Engineering is also responsible for the seven oil/water separators and underground tanks at Willow Grove ARF.

Fuel Operations

The third major category of industrial operations at Willow Grove ARF is the POL Fuel Farm area. This area (Building #231) consists of two fuel tanks (#207 - 210,000 gallons and #224 - 105,000 gallons), which store JP-4 fuel for use by the C-130 aircraft assigned to the 913th TAG. Fueling activities also include storage of contaminated JP-4 fuel in a 2000 gallon underground storage tank for eventual pickup by DPDO Philadelphia for sale, reclamation, or final disposal.

4.2.2 Hazardous Waste Generation and Management

While several areas throughout the Willow Grove ARF have been designated for temporary accumulation of hazardous materials, only one central waste storage location has been used for contractor or DPDO pick ups since activation of the base. The temporary accumulation areas are located adjacent to shop generation areas. Open Storage Area No. 42 is located in the northeastern portion of the base along Cinder Road adjacent to the POL Area, and is the central hazardous waste accumulation location.

The Hazardous Waste Management Plan for the 913th TAG outlines the locations and operations of the generator accumulation points. These accumulation point locations are illustrated in Figure 4-2. Figure 4-3 describes the key elements of the base hazardous waste management system. As the figure illustrates, the generator accumulation points collect wastes from the various shops and are managed by accumulation point managers. These individuals maintain records on the amount, type of waste, condition of containers, and dates of collection. The accumulation point managers are also responsible for conducting periodic inspections of the accumulation areas. The following accumulation points comprise the operating hazardous waste management system for the base:

- Aircraft Maintenance: AGE Storage Yard (Building #432)
- Aircraft Maintenance: Engine Shop (Building #201)

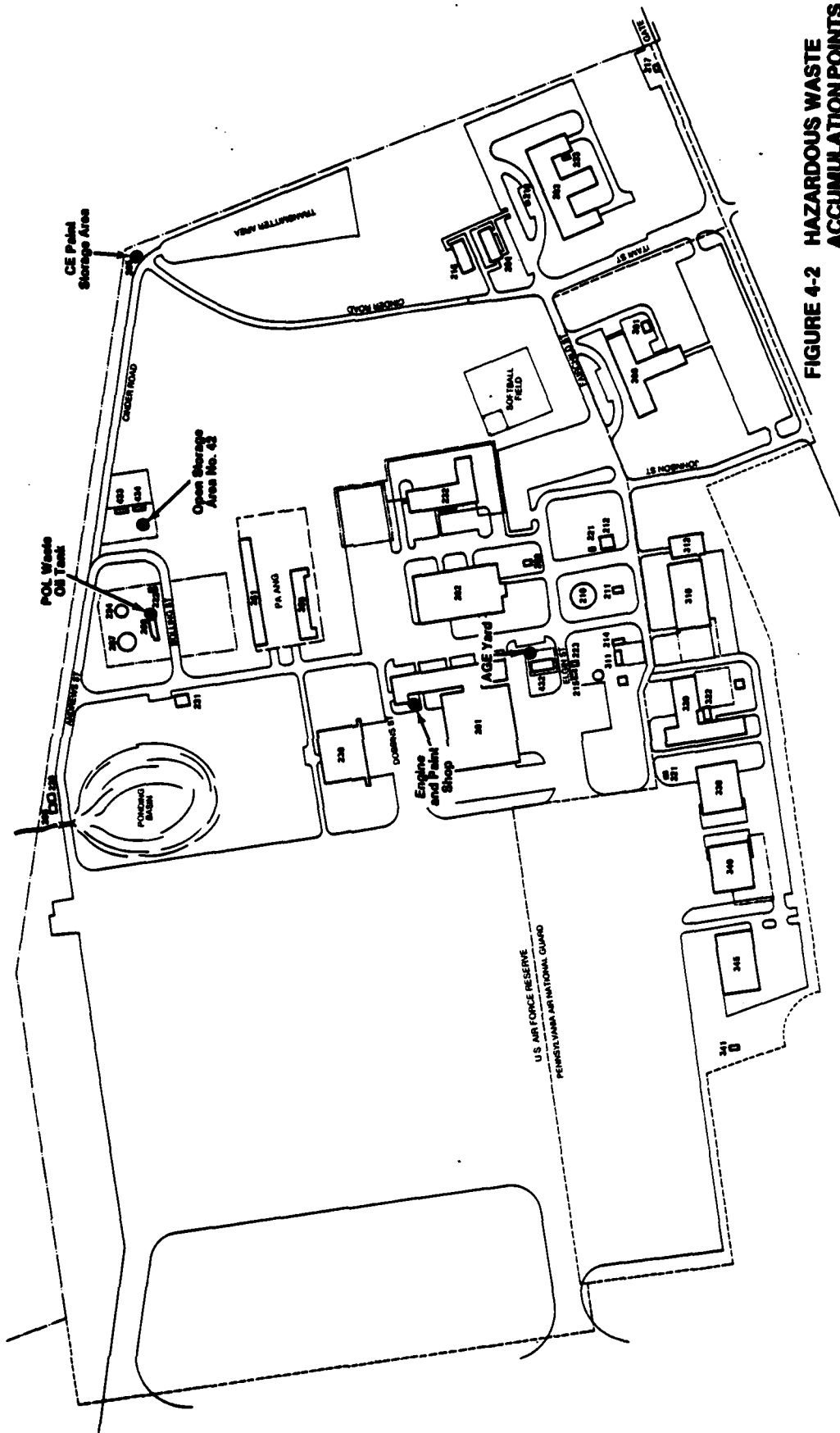
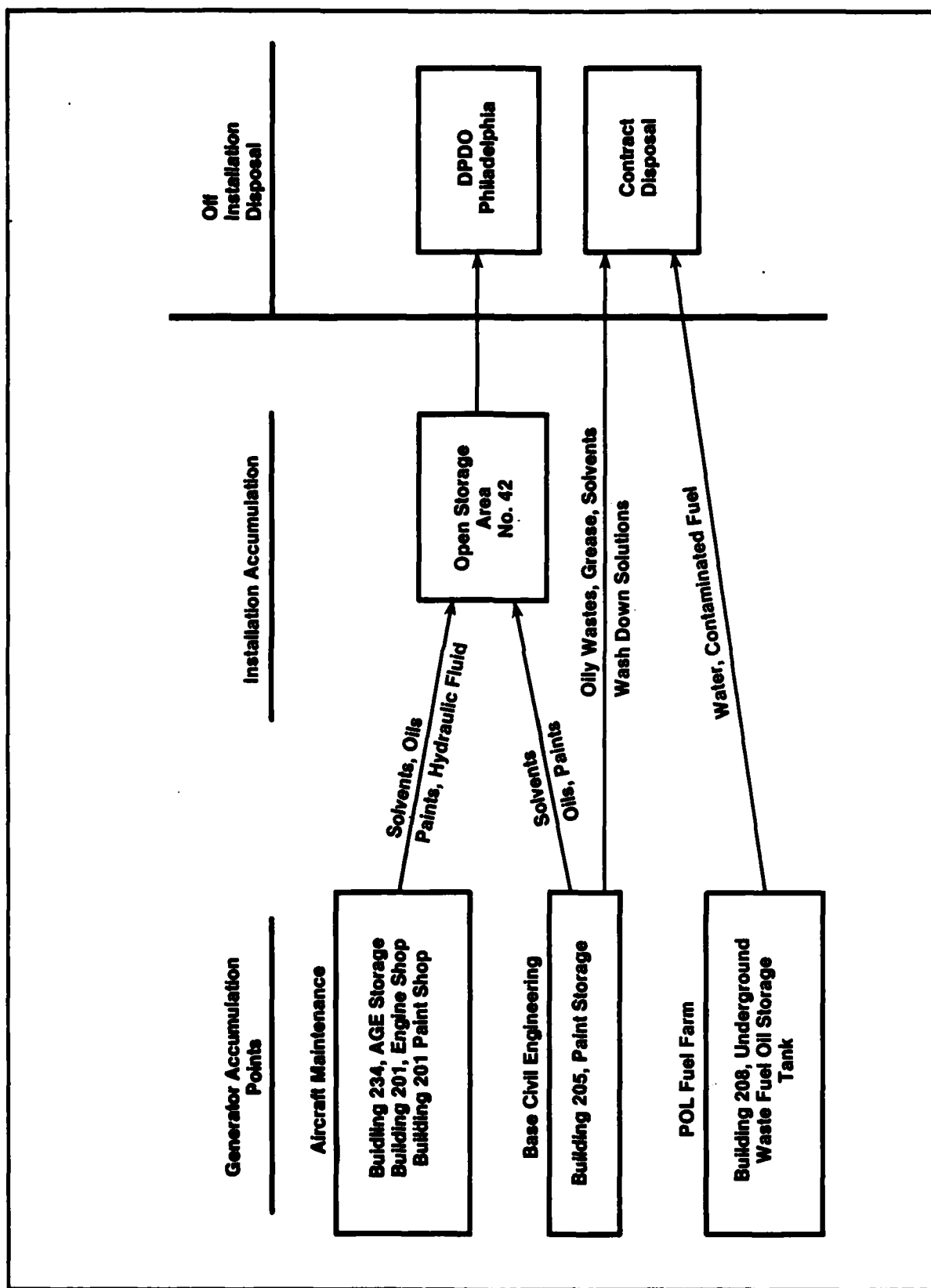


FIGURE 4-2 HAZARDOUS WASTE
ACCUMULATION POINTS
AND STORAGE LOCATIONS
AT 913TH TAG



**FIGURE 4-3 HAZARDOUS WASTE MANAGEMENT AT
WILLOW GROVE ARF 913TH TAG (1980 TO PRESENT)**

- Aircraft Maintenance: Paint Shop (Building #201)
- POL: Underground Waste Fuel Oil Tank (Building #208)
- Civil Engineering: Paint Storage Building (Building #205)
- Open Storage Area No. 42: Base Supply Secure Storage

The Open Storage area is intended to be a secure area for temporary accumulation of used petroleum products, hazardous materials and wastes, prior to pickup by the DPDO contractor. This site will be discussed in more detail in Section 5, because it is recommended for further confirmation analysis.

The list of hazardous wastes/materials generated by the 913th TAG are shown in Table 4-1. Also shown is the hazard classification, typical amount generated monthly, and type of accumulation point. Table 4-1 indicates that the major hazard associated with the wastes generated by the 913th TAG is flammability. All wastes generated are stored above ground in drums, with the exception of contaminated JP-4 fuel, which is stored in an underground tank.

As shown in Figure 4-3, materials accumulated at Open Storage Area No. 42 are picked up by DPDO Philadelphia when requested by Base Supply. Other materials accumulated by Base Civil Engineering, such as oily wastes (from the seven oil/water separators on the base), grease, solvents, and washdown solutions are picked up by commercial disposal contractors. This is also the primary method of disposal for contaminated JP-4 fuel oil generated at the POL fuel farm. Table 4-2 summarizes the shop-by-shop generation of hazardous materials/wastes at the 913th TAG.

TABLE 4-1

**HAZARDOUS MATERIAL/WASTE GENERATION
913th TAG
WILLOW GROVE AIR RESERVE FACILITY**

Common/Chemical Name	Hazard. Class	Typical Monthly Qty. Gener.	Type of Storage
Contaminated JP-4	Flammable Liquid	315 Gal.	2,000 Gal. Under- ground Storage Tank
PD-680 Degreaser	Flammable Liquid	70 Gal.	55 Gal. Drums
Lacquer & Enamel Stripper	Flammable Liquid	4 Gal.	5 Gal. Drums
Epoxy Stripper	Flammable Liquid	4 Gal.	5 Gal. Drums
Astrocoat Stripper	Flammable Liquid	10 Gal.	5 Gal. Drums
Polyurethane Thinner	Flammable Liquid	10 Gal.	5 Gal. Drums
Acetone	Flammable Liquid	10 Gal.	5 Gal. Drums
Toluene	Flammable Liquid	20 Gal.	5 Gal. Drums
Poly-Primer Thinner	Flammable Liquid	6 Gal.	5 Gal. Drums
Acrylic Thinner	Flammable Liquid	20 Gal.	5 Gal. Drums
Methyl Ethyl Ketone	Flammable Liquid	8 Gal.	5 Gal. Drums
Isopropyl Alcohol	Flammable Liquid	2 Gal.	5 Gal. Drums
Paint & Dope Thinner	Flammable Liquid	20 Gal.	5 Gal. Drums
Aircraft Engine Oil	Flammable Liquid	50 Gal.	55 Gal. Drums
Mineral Oil	Flammable Liquid	20 Gal.	55 Gal. Drums
Hydraulic Fluid	Flammable Liquid	30 Gal.	55 Gal. Drums

TABLE 4-2

SHOP-BY-SHOP HAZARDOUS MATERIALS/WASTES GENERATION - 913th TAG
(1957 to Present)

Shop Name	Location (Building Number)	Waste Materials	Waste Quantity	Waste Management Practices		
				1960	1970	1980
AGE	201	FD-680 Solvent	220 gal./yr.	- - -	- Fire Training - - -	- - -
		Penetone Power Cleaner	155 gal./yr.	- - -	- Sanitary Sewer - - -	- - -
		Lubricating Oil	2 gal./yr.	- - -	- Contractor/Fire Training - - -	- - -
Battery	201	Sulfuric Acid	350 gal./yr.	- - -	- Neutralized to Sanitary Sewer - - -	- - -
Corrosion Control	201	Acetone	40 gal./mo.	- - -	- Contractor/Fire Training - - -	- - -
		Toluene	40 gal./mo.	- - -	- Contractor/Fire Training - - -	- - -
		Epoxy Stripper	12 gal./yr.	- - -	- Contractor/Fire Training - - -	- - -
		Astrocoat Stripper	12 gal./yr.	- - -	- Contractor/Fire Training - - -	- - -
		Paint Thinners	45 gal./mo.	- - -	- Contractor/Fire Training - - -	- - -
		Alodine 1201	1-1/2 gal./yr.	- - -	- Contractor/Fire Training - - -	- - -
		Zinc Chromate	16 gal./mo.	- - -	- Contractor - - -	- - -
Life Support	201	111 Trichloroethane	12 gal./yr.	- - -	- Contractor/Fire Training - - -	- - -
Machine Shop	201	Motor Oils	50 gal/yr	- - -	- Contractor/Fire Training - - -	- - -
		111 Trichloroethane	Unknown	- - -	- Contractor/Fire Training - - -	- - -
		Grease	50 gal./yr.	- - -	- Contractor - - -	- - -
NDI	201	Film Developer	10 gal./yr.	- - -	- Contractor - - -	- - -
		ZY-GLO Developer	Unknown	- - -	- Contractor - - -	- - -
Pneudraulics	201	111 Trichloroethane (Inhibisol)	4 gal./mo.	- - -	- Contractor or Fire Training - - -	- - -
		PD-680	80 gal./yr.	- - -	- Contractor or Fire Training - - -	- - -

TABLE 4-2
(Con't)

SHOP-BY-SHOP HAZARDOUS MATERIALS/WASTES GENERATION - 913th TAG
(1957 to Present)

Shop Name	Location (Building Number)	Waste Materials	Waste Quantity	Waste Management Practices		
				1960	1970	1980
POL	231	JP-4	500 gal./yr.	- - -	- Contractor/Fire Training-	- DPDO ->
		Gasoline	10 gal./yr.	- - -	- Contractor/Fire Training-	- DPDO ->
		Fuel Oils	Unknown	- - -	- Contractor/Fire Training-	- DPDO ->
Propulsion	201	111 Trichloroethane	12 gal./yr.	- - -	- Contractor/Fire Training-	- DPDO ->
		PD-680	100 gal./yr.	- - -	- Contractor/Fire Training-	- DPDO ->
Repair/ Reclamation		PD-680	500 gal./yr.	- - -	- Contractor/Fire Training-	- DPDO ->
		111 Trichloroethane	2 gal./mo.	- - -	- Contractor/Fire Training-	- DPDO ->



The base has not operated any open dumping or chemical landfill areas during its operations, although occasional spillage of hazardous materials in the past may have occurred near Open Storage Area No. 42. Also, tank cleaning sludges at the POL area have been buried in accordance with Air Force technical orders. Navy operated landfills have been used for refuse disposal, and most hazardous chemical wastes have been removed from the base for contractor disposal, open burning or DPDO disposal. Up until the mid-1970's, flammable materials/wastes (contaminated fuels, oils, and solvents) were collected by the base fire department for fire training exercises at the Navy-operated open burning pit. All remaining waste materials (including flammable wastes not burned during fire training exercises) were collected by an off-base contractor for disposal or resale.

Hazardous materials/waste have been segregated in 55-gallon drums for DPDO collection since about 1975. The overall goal of DoD has been to implement a plan for recovery of waste petroleum products. Waste-generating activities (base shops) produce either recoverable products or waste products. Waste products are no longer suitable for any use, because of excessive contamination or degradation, and cannot be reprocessed or re-refined. Recoverable products, however, can be either reclaimed (used to meet another grade or specification without re-refining) or recycled (recovered for original use or specification through reprocessing). Some of the recoverable products at the 913th TAG handled by DPDO include:

- Aviation Fuels
- Ground Fuels

- Engine and Equipment Lubricating Oils
- Petroleum-base Solvents
- Hydraulic Fluids
- Calibrating and Purging Fluids

4.3 111th Pa AIR NATIONAL GUARD

The 111th PaANG industrial operations include a variety of aircraft repair and maintenance activities. The facilities of the 111th PaANG are shown in Figure 4-3. The major aircraft maintenance work centers are in Building #320, which is the location for Buildings #330 and #340, which are the major aircraft maintenance hangars.

A summary of the major types of hazardous materials/hazardous wastes handled by the 111th PaANG is shown in Table 4-3. As shown, the monthly generation of these materials is relatively small. Table 4-4 presents estimates of hazardous waste quantities and methods of disposal for each major shop. The 111th PaANG started operating at Willow Grove in 1963, and, therefore, the information presented includes 1963 to present.

4.4 FUELS MANAGEMENT

4.4.1 POL Fuel Area

The fuels management system at the Willow Grove ARF comprises the POL area, which is located in the north-central section of the base, as well as other fuel storage tanks throughout the base. Table 4-5 outlines these fuel storage tanks, and Figure 4-5 provides a schematic of the fuel tanks. The POL consists of two concrete-lined areas for aircraft fuel storage tanks.

WESTERN

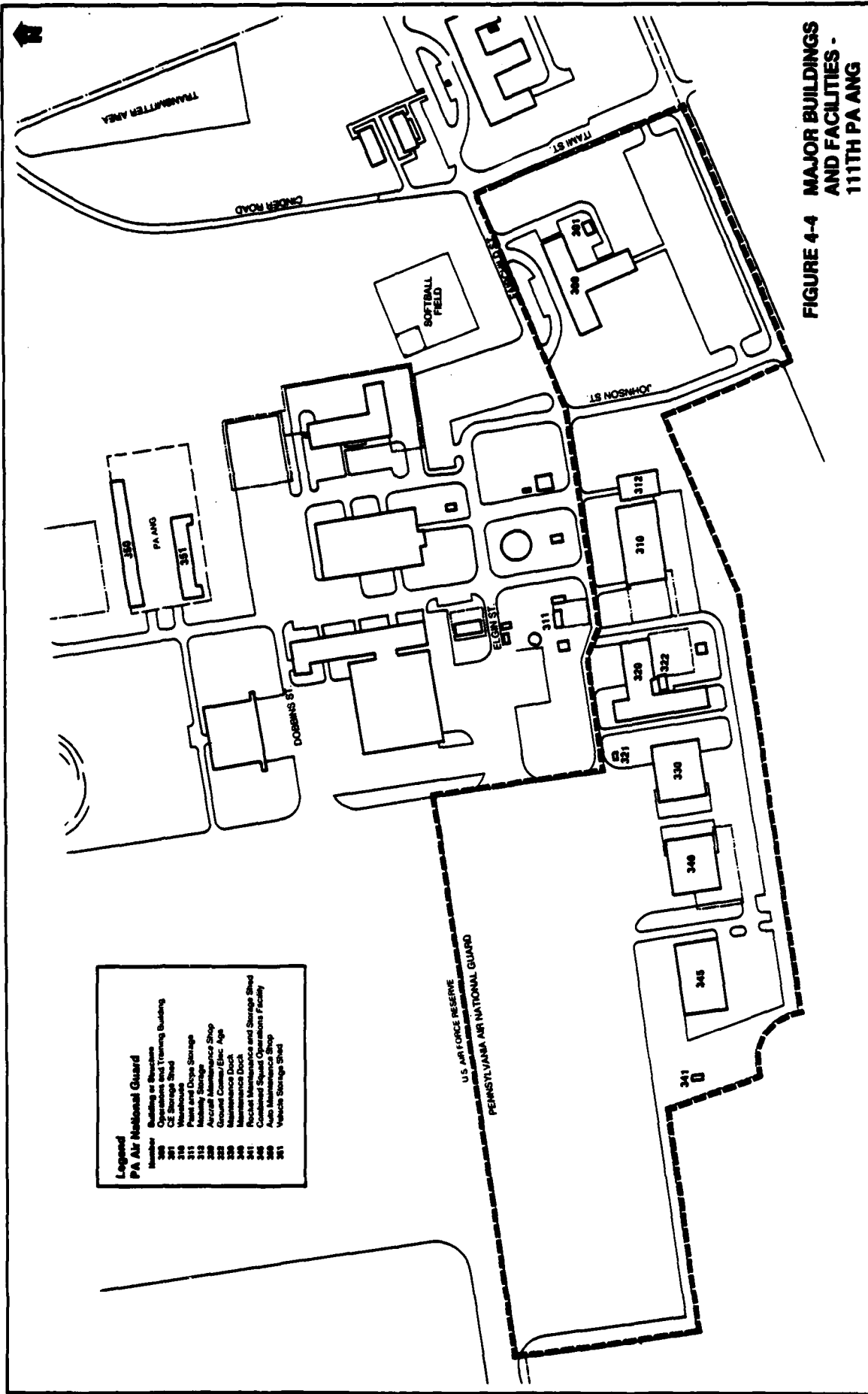


FIGURE 4-4 MAJOR BUILDINGS AND FACILITIES - 111TH PA ANG

TABLE 4-3

**HAZARDOUS MATERIAL/WASTE GENERATION
111th PaANG
WILLOW GROVE AIR RESERVE FACILITY**

Common/Chemical Name	Hazard. Class	Typical Monthly Qty. Gener.	Type of Storage
PD-680 Degreaser	Flammable Liquid	50 Gal.	55 Gallon Drums
Hydraulic Fluid	Flammable Liquid	20 Gal.	55 Gallon Drums
Mineral Oil	Flammable Liquid	2 Gal.	55 Gallon Drums
Aircraft Engine Oil	Flammable Liquid	30 Gal.	55 Gallon Drums
Toluene	Flammable Liquid	2 Gal.	5 Gallon Drums
Paint & Dope Thinner	Flammable Liquid	2 Gal.	5 Gallon Drums
Sulfuric Acid H ₂ SO ₄ (Battery Acid)	Corrosive	2 Gal.	5 Gallon Drums
Used Motor Oil and Hydraulic Fluids	Flammable Liquid	40 Gal.	55 Gallon Drums

TABLE 4-4

**SHOP-BY-SHOP HAZARDOUS MATERIAL/WASTE GENERATION - 111th PAANG
(1963 to Present)**

Shop Name	Location (Building Number)	Waste Materials	Waste Quantity (1963-1966)		Waste Management Practices		
				(1966-Present)	1960	1970	1980
Base Civil Engineering	232	Bromochloromethane	3 cans/yr.	4 cans/yr.			Sanitary Sewer/Contr. →
Base Supply	310	Empty Lead Acid Batteries	5/mo.	6/mo.			DPDO →
Base Photo Lab	300	Acetic Acid	1/3 gal./yr.	1/2 gal./yr.			Sanitary Sewer →
Base Photo Lab	300	NH-5 Hypoconcentrate,	1 qt./mo.	1 qt./mo.			Sanitary Sewer →
Aircraft Maintenance	320, 330, 340	Empty Paint Cans, Thinner Cans, Spray Cans, and Cleaning Cloths	20 cans/yr.	40 cans/yr.			Contractor Disposal →
Aircraft Maintenance	320, 330, 340	Paint Thinner	1 gal./mo.	2 gal./mo.			DPDO →
Aircraft Maintenance	320, 330, 340	Cleaning Cloths and Granular Materials for Collection of Oil Droppings, Contaminated with Oil and Brake Fluid; Empty Oil Cans	1 cu.yd./mo.	1.2 cu.yd./mo.			Contractor Disposal →

WESTON
CONSULTANTS

TABLE 4-4
(Con't)

SHOP-BY-SHOP HAZARDOUS MATERIAL/WASTE GENERATION - 111th PANG
(1963 to Present)

Shop Name	Location (Building Number)	Waste Materials	Waste Quantity		Waste Management Practices	
			(1963-1966)	(1966-Present)	1960	1970 1980
Aircraft Maintenance	320, 330, 340	Hydraulic Fluid	2 qt./mo.	3 qt./mo.		1 - Contractor - - DPDO
Aircraft Maintenance	320, 330, 340	PD-680 Degreaser	3 gal./mo.	5 gal./mo.		1 - Fire Training - DPDO
Aircraft Maintenance	320, 330, 340	Waste Engine Oil	50 gal./mo.	40 gal./mo.		1 - DPDO
Transportation Motor Pool	350	Hydraulic Fluid	.5 gal./mo.	.8 gal./mo.		1 - Contractor - - DPDO
Transportation Motor Pool	350	PD-680 Degreaser	1 gal./mo.	2 gal./mo.		1 - Fire Training - DPDO
Transportation Motor Pool	350	Hydrochloric Acid	1 qt./mo.	2 qt./mo.		1 - Neutraliz./Sanitary Sewer
Transportation Motor Pool	350	Used Motor Oil	40 gal./mo.	40 gal./mo.		1 - DPDO

WESTON
CONSULTANTS

TABLE 4-4
(Con't)

SHOP-BY-SHOP HAZARDOUS MATERIAL/WASTE GENERATION - 111th PaNG
(1963 to Present)

Shop Name	Location (Building Number)	Waste Materials	Waste Quantity		Waste Management Practices		
			(1963-1966)	(1966-Present)	1960	1970	1980
Transportation Motor Pool	350	Empty Paint Cans, Thinner Cans, Spray Cans, and Cleaning Cloths	80 cans/yr.	160 cans/yr.		Contractor	
Transportation Motor Pool	350	Paint Thinner	2 gal./mo.	3 gal./mo.	DPDO		
Transportation Motor Pool	350	Cleaning Cloths and Granular Material for Collection of Oil Droppings, Contaminated with Brake Fluid; Oil Cans	1 cu.yd./mo.	1.5 cu.yd./mo.		Contractor	
Transportation Motor Pool	350	Battery Acid "Sulfuric"	1 gal./mo.	1.2 gal./mo.		Neutrlz./Sanitary Sewer	

WESTON
COMBATANTS

TABLE 4-5
FUEL STORAGE TANKS
WILLOW GROVE AIR RESERVE FACILITY

Location	Fuel Type	Capacity (gal.)	Above or Below Ground	Tank Type
Power Plant Bldg. 212	No. 2 Fuel Oil	588	Above	Steel
Maint. Hangar Bldg. 201	Waste Oil (Separator)	250	Below	Steel
Maint. Hangar Bldg. 201	Waste Oil (Separator)	250	Below	Steel
FOL Bldg. 208	FOL Waste Oil	2,000	Below	Steel
Pump Station Bldg. 211	Diesel Fuel	533	Below	Steel
Well House Bldg. 209	Diesel Fuel	533	Below	Steel
Lift Station Bldg. 220	Diesel Fuel	275	Below	Steel
PaANG Maint. Bldg. 330	Waste Oil (Separator)	275	Below	Steel
Admin. Bldg. 203	Diesel Fuel	275	Below	Steel
PaANG Motor Pool Bldg. 352 F'glass		Gasoline	6,000	Below
ANG Motor Pool Bldg. 352	Diesel Fuel	6,000	Below	F'glass
ANG Motor Pool Bldg. 350	Waste Oil (Separator)	850	Below	F'glass
Fuel Cell Repair Bldg. 230	Waste Oil (Separator)	5,000	Below	Concrete
Fuel Cell Repair Bldg. 230	No. 2 Fuel Oil	6,000	Below	Steel
FOL Lab Bldg. 231	No. 2 Fuel Oil	1,000	Below	Steel
FOL Lab Bldg. 231	Waste Oil (Separator)	150	Below	F'glass
CE Yard Bldg. 232	Waste Oil (Separator)	150	Below	F'glass
FOL Tank 207	JP-4 Fuel	210,000	Above	Steel
Power Plant Tank 221	No 6 Fuel Oil	20,000	Above	Steel
FOL Area Tank 222	No. 6 Fuel Oil	14,994	Above	Steel
FOL Tank 224	JP-4 Fuel	105,000	Above	Steel

Legend

- Waste Oil Tank With Oil Separator
- Waste Oil Tank Without Separator
- Fuel Oil or Diesel Tank

FIGURE 4-5 LOCATION OF FUEL STORAGE AND WASTE OIL TANKS AT WILLOW GROVE ARF

FIGURE 4-5 LOCATION OF FUEL STORAGE AND WASTE OIL TANKS AT WILLOW GROVE ARF

The two storage tanks (#207 - 210,000 gallons and #224 - 105,000 gallons) contain JP-4. Each steel tank is constructed above ground within a separate containment dike. The containment volume of each dike is greater than the tank capacity plus one foot freeboard.

Drains from the containment dike areas are equipped with manual valves to remove rainwater. All drainage flows through a catch basin before discharge into the base holding pond. The concrete-lined dikes and catch basin were constructed in 1981. During these tank reconstruction activities, a french drain system was installed under Tank #207 to collect and drain high groundwater flows into the sump. The french drain did not operate properly and was subsequently abandoned.

The POL area contains a storage tank for heating oil, with a capacity of 15,000 gallons. The tank is located on a raised platform with no spill containment structures. The tank is currently empty, but was used from 1958 to 1971 for the storage of aviation lube oils, and from 1978 to 1984 for the storage of #6 fuel oil as a backup supply for the heating plant.

In addition to the above-ground heating oil tank, the POL area contains an underground waste oil tank with a capacity of 2,000 gallons. Contaminated JP-4 fuel is stored in this tank prior to removal and disposal. Removal is contracted out approximately twice a year. Prior to 1980, these waste fuels were burned for fire training exercises.

Five fuel storage tank trucks, each with a 5,000 gallon capacity are maintained on the base. Four of the trucks are used for JP-4 jet fuel and the fifth is used for MOGAS. No spill containment measures exist for the tank truck loading/unloading areas.

Tank inspections and cleaning activities are performed at a 3-year frequency. The tank contents are pumped down for use as far as possible, and the remaining fuel and contaminated fuel/residue is removed by contractor. The sludge is removed and disposed through the contractor. Until mid-1970's, this tank residue was buried within the POL area.

4.4.2 Fuel Spills

Small fuel spills have occurred frequently throughout many areas of the base, predominantly on the flightline and the aircraft apron. Table 4-6 outlines a compilation of small fuel spills as described within base fire department records. Small fuel spills on paved areas have been typically washed down by the fire department with the resulting wastewater flowing through storm sewers to the base holding pond.

The base Spill Prevention Control and Countermeasures Plan (SPCC Plan) outlines four additional areas where polluting substances are stored and contaminated spills are possible. These areas include:

- POL Storage Tank Areas
- Heating Oil Storage Tank (#212)
- Heating Plant Oil Storage Tank (#221)
- Tank Truck Area

At least three significant fuel spills have been identified at the POL storage tank area, and a smaller fuel oil spill has been identified at the Heating Plant oil storage tank. Approximately 50 gallons of #6 fuel oil was spilled in the winter 1984 during refueling

TABLE 4-6

SUMMARY OF SMALL
QUANTITY FUEL SPILL RESPONSES
(October 1980 - May 1983)

Date	Spill Location	Spill Response	Estimated Quantity (gal.)
24 October 1980	AF Ramp	Fuel Spill Wash Down	50
7 November 1980	C-130 Line	Meter Fuel Line on Vehicle	10
12 December 1980	AF Ramp	Wash Down Defuel Truck Leak	10
7 February 1981	C-130 Line	Fuel Spill Wash Down	10
7 February 1981	C-130 Line	Refueling Truck Spill	10
9 February 1981	AF Ramp	Fuel Spill Wash Down	20
27 March 1981	AF Ramp	Fuel Spill from Valve	20
14 May 1981	AF Hangar 201	Disconnect Fuel Line	10
14 May 1981	AF Hangar 201	Fuel Spill Wash Down	20
18 May 1981	AF Ramp	Fuel Leak at Engine	20
28 May 1981	AF Ramp B-1	Fuel Spill Wash Down	10
29 May 1981	PaANG Ramp	Fuel Spill Wash Down	10
13 June 1981	PaANG Ramp	Fuel Spill Wash Down	10
16 June 1981	PaANG Ramp	Fuel Spill Wash Down	20
1 July 1981	Engine Test Stand	Fuel Spill Wash Down	20
8 July 1981	PaANG Ramp	Fuel Spill Wash Down	25
8 July 1981	AF Ramp	Fuel Spill Wash Down	20
11 July 1981	AF Fuel Dock	Fuel Leak from Engine	10
15 July 1981	AF Ramp	Fuel Gasket Leak	10
15 July 1981	AF Ramp	Fuel Spill Wash Down	25
20 July 1981	Old A4 Turnup Pad	Dump Valve Leak	50
30 July 1981	PaANG Ramp	Fuel Spill Wash Down	10
5 August 1981	AF Line	Fuel Spill Wash Down	20
5 August 1981	A37 Line	Fuel Spill Wash Down	20
6 August 1981	AF Spot C4	Fuel Spill Wash Down	10
12 August 1981	AF FOL Area	Open Air/Fuel Vent Release	40
20 September 1981	Rear of Bldg. 320	Top of Truck Spill	10
13 October 1981	Hangar 201-S. Ramp	Fuel Spill Wash Down	25
17 November 1981	TA-37 Line	Fuel Spill Wash Down	10
3 December 1981	PaANG Ramp	Fuel Spill Wash Down	10
30 December 1981	PaANG Ramp	Fuel Spill Wash Down	10
6 January 1982	A-37 Line	Fuel Spill Wash Down	10
7 January 1982	PaANG Ramp	Fuel Spill Wash Down	20
8 January 1982	C-130 Line	Fuel Spill Wash Down	20
4 February 1982	PaANG Ramp	Fuel Spill Wash Down	20
10 March 1982	A-37 Line	Fuel Spill Wash Down	10
14 April 1982	PaANG Parking Ramp	Fuel Spill Wash Down	20
17 April 1982	PaANG Parking Ramp	Fuel Spill Wash Down	10
30 April 1982	AF Parking Ramp	Fuel Spill Wash Down	20

TABLE 4-6
(Con't)

**SUMMARY OF SMALL
QUANTITY FUEL SPILL RESPONSES**
(October 1980 - May 1983)

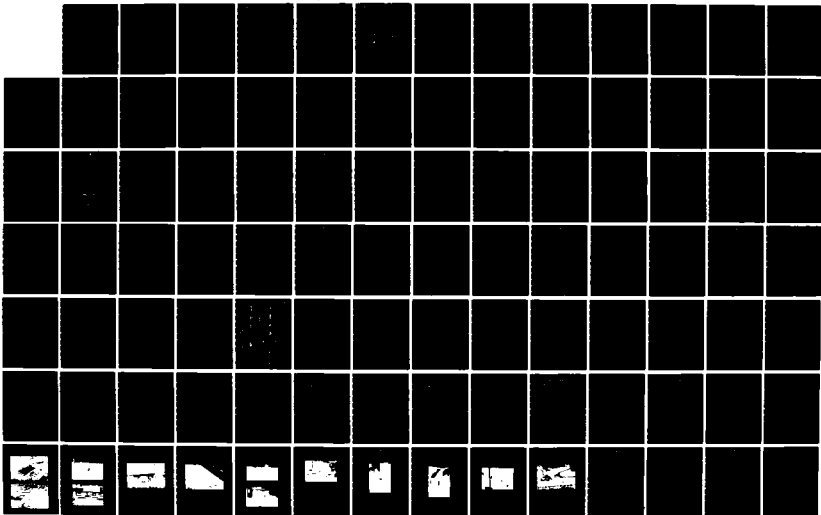
Date	Spill Location	Spill Response	Estimated Quantity (gal.)
2 May 1982	AF Ramp	Fuel Spill Wash Down	10
2 May 1982	AF Ramp	Fuel Spill Wash Down	20
13 May 1982	C-130 Line	Fuel Spill Wash Down	10
8 June 1982	AF/PaANG Line	Fuel Spill Wash Down	20
June 1982	Rear of Bldg. 320	JP-4 & Soil Cleanup	250
July 1982	C-130 Line	Fuel Spill Wash Down	40
July 1982	PaANG Runup Area	A-37 Dumping Fuel	15
August 1982	AF Ramp	Fuel Spill Wash Down	10
19 August 1982	PaANG Ramp	Fuel Spill Wash Down	10
7 September 1982	A-37 Line	Fuel Spill Wash Down	25
11 September 1982	A-37 Nose Dock #1	Fuel Spill Wash Down	10
21 September 1982	AF Ramp Spot 1	Fuel Spill Wash Down	20
October 1982	AF Ramp	Leaking Fuel Truck	100
2 October 1982	AF Ramp	Wash Fuel Truck Compartment	10
6 October 1982	PaANG Ramp	Spill JP-4	10
6 October 1982	PaANG Ramp	Spill JP-4	10
6 October 1982	PaANG Ramp	Maintenance Control Spill	10
14 October 1982	PaANG Ramp	Spill JP-4	10
21 October 1982	PaANG Prkg. Ramp A-37	Fuel Spill Wash Down	25
27 October 1982	A-37 Line	Fuel Spill Wash Down	110
3 November 1982	AF Ramp	Fuel Spill Wash Down	25
13 November 1982	AF Ramp	Fuel Spill Wash Down	10
27 December 1982	PaANG Ramp	Fuel Spill Wash Down	10
21 January 1983	PaANG A-37 Ramp	Fuel Spill Wash Down	15
9 February 1983	PaANG Ramp	Fuel Spill Wash Down	15
4 March 1983	Spot C-3, C-130 Ramp	Fuel Spill Wash Down	25
5 March 1983	AF Ramp	Fuel Spill Wash Down	10
5 March 1983	AF Ramp	Fuel Spill Wash Down	10
5 March 1983	PaANG Ramp	Fuel Spill Wash Down	10
6 March 1983	AF Ramp Spot B-3	Fuel Spill Wash Down	15
14 April 1983	PaANG Spot 2	Fuel Spill Wash Down	10
18 April 1983	AF Ramp	Fuel Spill Wash Down	15
8 May 1983	AF Ramp	Fuel Spill Wash Down	40
13 May 1983	A-37 Parking Ramp	Fuel Spill Wash Down	10
26 May 1983	AF Ramp	Fuel Spill Wash Down	10

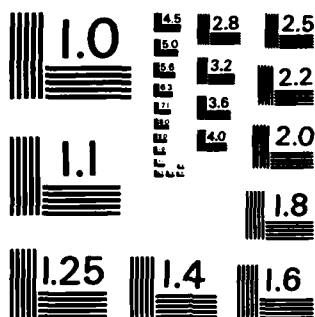
INSTALLATION RESTORATION PROGRAM PHASE I: RECORDS
SEARCH WILLOW GROVE AIR. (U) WESTON (ROY F) INC WEST
CHESTER PA 01 NOV 84 AF-058A F08637-83-C-6009

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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

activities at the heating plant Tank #221. The spill was contained within the concrete dike area, but no cleanup of the earthen base was performed.

Two POL fuel spills occurred in the 1960's when AVGAS was utilized on the base. In 1962, approximately 30,000 gallons of fuel spilled into the gravel and tar containment area from Tank #207 when the floating roof drain malfunctioned. The majority of the spill was collected and reclaimed (estimated at 28,000 gallons). An unknown quantity of fuel was discharged from the POL drain line in 1968 when fuel was mistaken for water and was released from the sump at the base of the tank area.

The most significant fuel spill identified at the POL area occurred in January 1979 when valve leaks at Tank #207 released an estimated 4,000 to 8,000 gallons of JP-4 into the gravel and tar dike area. Although the spill was contained and a large quantity recovered, migration of the fuel into the soil around the POL area was identified. Discharges of pure JP-4 were identified from the sidewall banks of the receiving pond in the summer of 1979. A groundwater monitoring program was initiated in 1980 when well points were installed between Tank #207 and the receiving pond. Absorbent booms have been installed at the discharge point of the pond and periodic inspections/replacements continue. No soil investigations or cleanup have been initiated, and hydrocarbon odors persist in the monitoring wells.

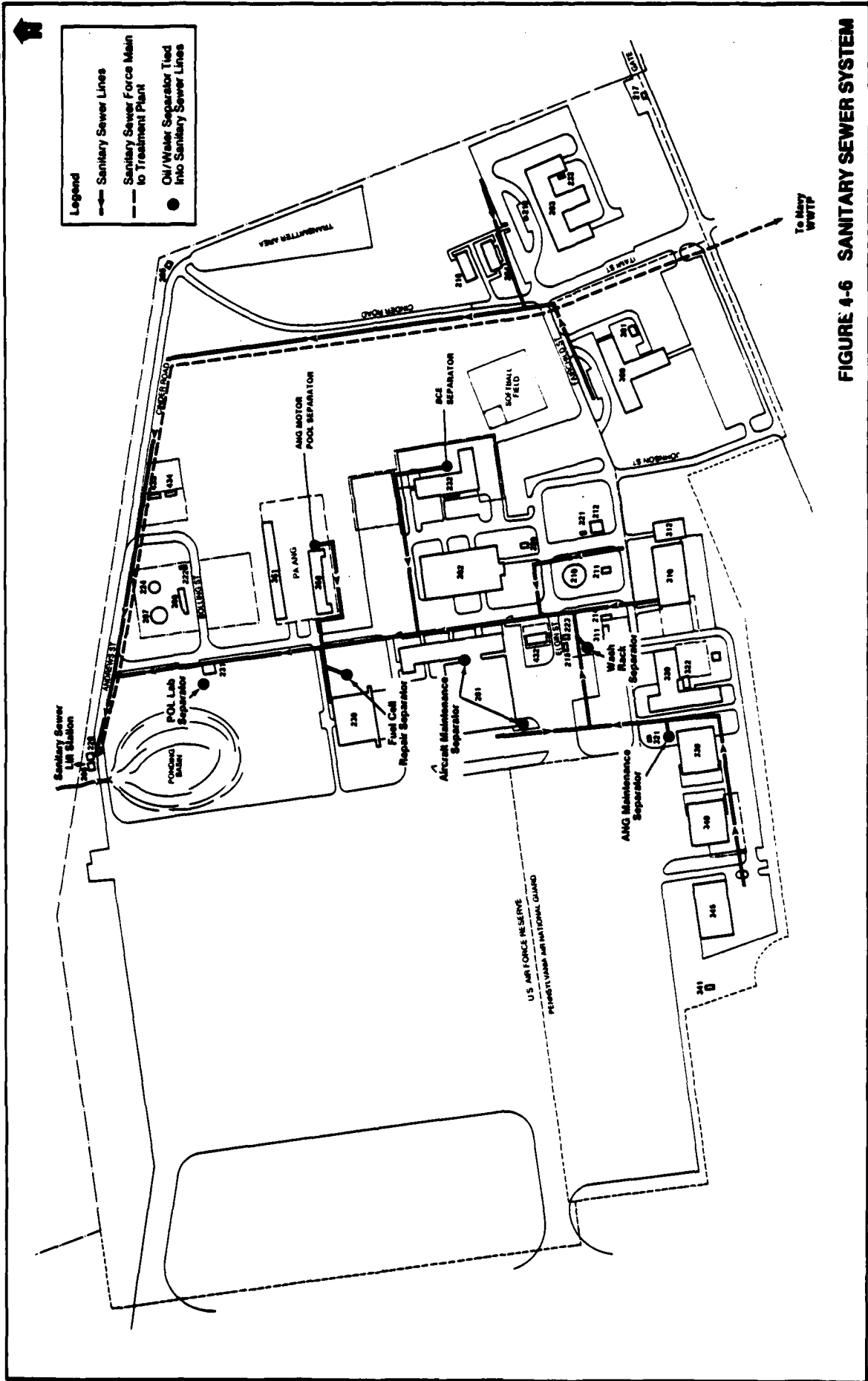
4.5 INDUSTRIAL WASTE CONTROL - SANITARY SEWER AND STORM SEWER SYSTEMS AT WILLOW GROVE ARF

Liquid industrial wastes have been controlled at the ARF through an established oil/water separator system and

through waste segregation and containerization. Figure 4-6 illustrates the sanitary sewer system as well as oil/water separators tied into the system. The aircraft maintenance hangars at the 913th TAG and the 111th PaANG contain oil/water separators which are tied into sanitary sewer lines. The fuel cell repair shop and the POL laboratory also contain oil/water separators which are connected to the sanitary sewer lines. The aircraft wash rack is equipped with a settling tank/oil skimmer as well as a trickling filter (used until the mid-1970's) which ties into the sanitary sewer line. Solvent and detergent mixes have been used for aircraft washing activities at the washrack. In addition, past paint stripping operations have been performed at the washrack. Waste oils are skimmed from the wastewater in the settling tank, and the effluent is passed through the trickling filter media. This rock and gravel media is not contained, but final effluent can flow into the sanitary sewer line.

All sanitary sewage flows by gravity to the sanitary sewer lift station (Buildings #206 and #220) where the effluent is monitored and pumped via force main to the trickling filter wastewater treatment plant operated by the Naval Reserve Station. The plant's capacity is 0.5 mgd.

All runoff and surface drainage from the 913th TAG flows along established drainage ditches and storm sewer lines into the ponding basin located at the north-central base property line. The surface drainage system for the base was described in Section 3 and is shown in Figure 3-2.



4.6 SITE FINDINGS

This section describes the seven sites on Willow Grove ARF which were found to have contamination due to past storage or disposal practices. The sites were identified through a number of sources, including AFRES and PaANG files, interviews with base personnel, and field examination. Figure 4-7 shows the locations of the seven sites. Each of the seven sites is recommended for a confirmation study. The confirmation study is discussed in Section 5 - Conclusions, and Section 6 - Recommendations.

4.6.1 POL Area - Site No. 1

The POL area is located in the northern perimeter between the Open Storage Area #42 and the ponding basin. The fenced area is approximately 400 feet by 200 feet, although historically, POL operations have taken place in adjacent areas outside the fence. The POL operations office and fuel testing laboratory are located in Building #231 east of the fenced area.

POL facilities inside the fenced area include two above-ground JP-4 tanks (#207 and #224), a 15,000-gallon above-ground fuel storage tank, a 2,000-gallon underground waste fuel tank next to the pump house (#208), fueling hydrants, and parking space for seven 5,000-gallon JP-4 tank trucks.

A 5,000-gallon tank truck parked on the street adjacent to the POL office (#231) is used to store and supply MOGAS. The fuel laboratory in Building #231 has an associated below-ground small capacity (150 gallon)

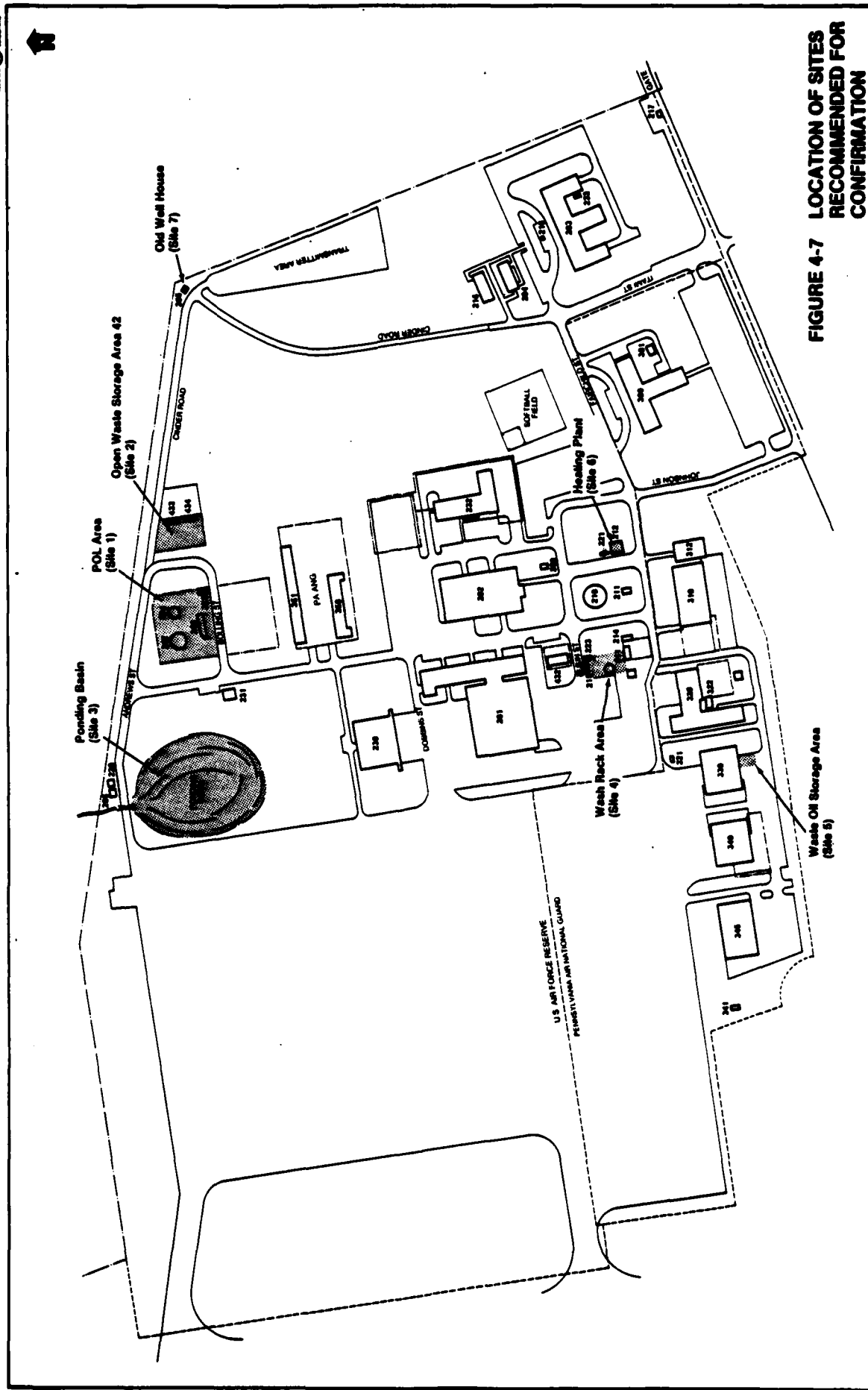


FIGURE 4-7 LOCATION OF SITES RECOMMENDED FOR CONFIRMATION

waste tank. All fuels used on-base are transported by truck; there are no underground fuel lines associated with the POL area.

The two JP-4 Tanks #207 and #224 have capacities of 210,000 and 105,000 gallons respectively. They were built during base construction in 1957, and have been used for JP-4 storage since that time. Both are built on a ring of concrete filled with four to five feet of sand. The original berms around the tanks were earthen, lined with a tar-gravel compound. In the summer of 1979, the berms were rebuilt and lined with concrete. Several spills of between 5,000 and 30,000 gallons of JP-4 are known to have occurred, particularly from #207, before the cement liners were installed. Although these spills are not documented in files, they were reportedly cleaned up with a minimum of loss to the subsurface. The latest spill occurred on January 25, 1979, due to a faulty or frozen roof valve, and is documented in a Pennsylvania Department of Environmental Resources file. At that time, approximately 8,000 gallons of JP-4 spilled into the moat around #207; 2,000 gallons of water were pumped into the bermed area to seal off the moat bottom, and all fuel was then pumped out and hauled away by a private salvage contractor.

Later in the spring of 1979, Tank #207 was drained for cleaning and remodeling of the roof. At that time, a leak in the floor of the tank was discovered, which accounted for losses of JP-4 from that tank reported in early 1974. Based on a review of the records, Base Civil Engineering estimates that 8,000 gallons of fuel entered the ground from that leak. Four monitor wells constructed of two-inch PVC were later installed between

the POL area and the ponding basin to the east, but there are no records available on well construction or on the results of chemical analyses if samples were taken. During WESTON's site visit in June 1984, there was an obvious odor of JP-4 in the casings of the two middle wells. In addition, oil seepage was visible along the western edge of the ponding basin for a length of about 100 feet.

Other POL operations may have resulted in fuel spills, although none are documented. The above-ground 15,000 gallon tank (#222) is supported by two concrete saddles with no liner or containment at ground surface. It was used to store 1100 aviation oil (a viscous lube oil for reciprocating engines) from about 1964 to about 1971. It was empty from 1971 to 1978, was used to store #6 furnace fuel from 1978 to early 1984, and is now being converted for MOGAS storage. The area outside the fence to the east, between the fence and Bolling Street, was used in the early 1960's as a bermed storage area. It was used approximately one year for storage of 1100 aviation oil in 55-gallon drums, then was left empty until it was filled in 1981 with clean fill and seeded over. Across the street from this area, on the landing mat between Bolling Street and the west fence of the Open Waste Storage Area #42 (Site No. 2), a 4,000-gallon tank trailer was parked from 1958 to about 1964 and used for storage of 1100 aviation oil before it was replaced by Tank #222. The base fire chief reported that when a welder was called in to cut up some of the landing mat in this area in 1983, his torch set off a series of small ground fires indicating the presence of flammable substances on the soil. No major spills of 1100 aviation oil are known to have occurred. However, assuming that 20 gallons a year were spilled near the tank during normal operations, as much as 120 gallons could be in the ground from this source.

Another practice which would have contributed to contamination of the ground with fuel oil and metals was burying the sludge from cleaning of Tanks #207 and #224. Approximately once every three years, between 1958 and the mid-1970's, these tanks were drained and vacuum cleaned. The thickest, leaded sludge from the tank bottom was scraped out and buried underground in the western corner of the fenced area. An estimated 150 gallons of fuel sludge were buried at this site.

4.6.2 Open Storage Area #42 - Site No. 2

The open storage area is an area approximately 200 feet by 150 feet that has been used for storage of hazardous materials/waste in drums and equipment (both operational and non-operational) since construction of the base in 1957. The ground is covered with steel landing mat and is fenced. The site has historically extended beyond the present fence as far as the edge of Bolling Street to the west. The area was unfenced until 1972, then closed with a barbed wire fence until 1982. In 1982 an 8-foot tall chain-link fence was installed around the perimeter, although some equipment is still stored outside the fence on the east side. At that time, a fence was also erected through the middle of the site to segregate drummed hazardous materials/wastes and equipment on the west side from gas cylinders on the east side. Shelters were erected to protect the gas cylinders which contain nitrogen, oxygen and hydrogen. The rest of the site has been and remains open and uncovered.

The site serves as a central collection and storage point for hazardous materials/wastes generated through the ARF. Following a request by either AFRES or PaANG,

Base Supply picks up waste materials in cans or drums at an accumulation point or at an individual shop, and transfers them to the Open Storage Area #42. Approximately once every three months, Base Supply contacts the DPDO, Philadelphia to initiate a pick-up of all materials stored at the site which is made by a private contractor. Certain materials, specifically from the NDI Shop and Medical Services, are never transferred to the Open Storage Area, but are picked up by DPDO directly at the point of generation.

Materials currently at the site include spent engine oil, hydraulic fluid, and solvents (PD-680, 1,1,1,tri-chloroethane, lacquer thinner, paint stripper). Since 1980 these materials have been segregated into different drums, and an attempt has been made to follow a color coding system for the drums. Drums of new stock, including methanol, de-icing fluid and lube oil, were also observed. At the time of the site visit, approximately 100 drums were stored at the site. The last DPDO pick up had been in January 1984. Most of the drums were stored upright, approximately half of them on wooden pallets; a few drums were lying on their sides. In many places, drums of different types of wastes were stored next to each other or mixed together, and several drums had no visible label, or coded color band. Several drums of waste engine oil were observed to be leaking onto the ground, and ground discoloration was observed through the landing mat in many places. Equipment stored inside the fenced area included fencing, metal shelving, and combat training equipment in crates, and approximately 30 empty car battery casings were stored on a pallet next to the gate. Five transformers were stored on a pallet near the west

fence. However, they do not contain PCB's. Although the gate is locked, access to the site is not restricted to Base Supply. Several services in both the AFRES and PaANG have keys to the site to permit loading and unloading of equipment. Traffic is particularly heavy during weekend training periods, increasing the chances of damage to the waste containers.

4.6.3 Ponding Basin - Site No. 3

The ponding basin is a man-made pond approximately two and a half acres in area. It was built by damming and excavating a stream bed at the natural low point of the property when the facility was first developed in 1957. The original capacity of the pond was 3.5 million gallons, and in the summer of 1979 it was enlarged to 5.8 million gallons. The ponding basin receives all storm runoff from the ARF and a portion of the storm runoff from the NAS.

The ponding basin is operated by the U.S. Navy Public Works Water Supply and Wastewater Treatment Facility as a catchment pond where floating products (oil or detergent) can be removed from surface water before it is discharged from the property. Prior to 1979, the pond was maintained at a single level. After enlargement in 1979, it was equipped with a gate which can be manually adjusted according to rainfall and rate of runoff. The discharge area is equipped with two sets of absorbent booms designed to skim petroleum products from the water surface. When large slicks of oil or foaming detergents form on the surface, a private contractor is called in to pump them off.

Due to its position at the discharge point for surface water and its function as a retention pond, the ponding basin is suspected of being the receptacle of a variety of wastes over the last 26 years. Fuels, solvents and detergents are likely to have been carried to the ponding basin through the storm sewer system due to improper handling or accidental spills on the flight apron, in shop areas or in the POL area. When the pond was enlarged in 1979, JP-4 was observed flowing into the excavated area along the bedrock-overburden interface on the east bank, and oil seeps are still in evidence today. Most floating and soluble waste products would have been skimmed off or washed downstream to Graeme Park and Park Creek. In fact, several fish kills have reportedly occurred downstream during the years of base operation. These were not documented, however, in either Air Force or Pennsylvania Department of Environmental Resources files. In addition, the heavier solid components of liquid wastes may have settled to the bottom of the pond and become bound in the bottom sediments.

4.6.4 Washrack Area - Site No. 4

The washrack area includes the washrack, (located southeast of Hangar 201), and associated structures including an oil/water separator and filter bed, two paint storage buildings (#215 and #223), the grassy area (approximately 50 feet by 50 feet) contained between these structures, and a ditch to the east.

The washrack is used primarily for washing aircraft from both AFRES and PaANG facilities. Personnel from the Paint Shop in Hangar 201 are responsible for supervising aircraft washing for the 913th TAG. Since 1979, air-

craft washing has been done by a private contractor. Currently, approximately 20 aircraft a year are washed on the washrack. In the past, as many as 160 aircraft a year have been washed there. Since 1979, approximately 10 gallons per aircraft of Super II Detergent (Mil. Spec. No. C-25769) have been used, and two gallons per aircraft of "soil barrier", an anti-corrosion agent painted on behind the engines after washing. In the past, a cleanser/solvent (Mil. Spec. No. C-43616B) was used in combination with the detergent for aircraft cleaning. A small amount of the solvent PD-680 is still sprayed on parts of the aircraft to loosen dirt just before washing.

A secondary use for the washrack has been paint stripping. Parts too large to fit in a dip tank have been stripped directly on the washrack, then hosed down. Other small parts have been hosed off on the washrack after stripping in a tank. Solvents used in stripping include lacquer and enamel strippers, epoxy stripper, astrocoat stripper and methyl ethyl ketone (MEK). Approximately five gallons per month of strippers are used in the paint shop. It can be assumed that approximately 20% of these are not recovered, but are instead flushed into the washrack effluent treatment system, amounting to 12 gallons per year.

A portion of the washrack effluent is passed through a filter bed which is in direct connection with the subsurface, probably at or very close to the water table. The estimated depth to bedrock at this site is six feet, and the stone filter bed appears to have been excavated to that depth based on design drawings provided by AFRES-CE. Assuming that an average of 30

aircraft a year were washed on the washrack over a 26-year period, and that 12 gallons per year of paint strippers were discharged in the effluent, it is estimated that 7,800 gallons of detergent (including some solvent), and 300 gallons of paint strippers, have been discharged to the disposal system in the operating life of the ARF. Of this, it can be assumed that approximately 10% was lost to the ground. Thus 780 gallons of detergent/solvent and 30 gallons of paint strippers have reached the groundwater system. In addition, a small portion of the oils and fuel combustion by-products washed from the aircraft may have also reached the aquifer.

Immediately adjacent to the washrack area are two storage buildings (Building #215 and #223), historically used for storage of partially used containers of paint, paint thinners, paint strippers, solvents and detergents. Since 1983, Building #215 has been used to house a cold dip tank containing the stripper B&B 121. Touch-up stripping using solvents such as MEK is also performed in the shed by the 913th TAG, and outdoors in back of the shed by the 111th PaANG. Evidence of vegetation stress around this building indicates that improper handling of these materials may have resulted in some spillage to the ground. It is not possible, however, to quantify these losses.

4.6.5 Building #330 Waste Oil Storage Area - Site No. 5

The Waste Oil Storage Area is a relatively small area (100 sq. ft.) behind Building #330 which was used as a storage area for an above ground tank (bowser). The bowser was used between 1970 to 1980 as a receptacle of waste oils from various shops of the 111th PaANG.

The bowser was removed in 1980, however, evidence of oil contamination was found in the area around the tank. Overfilling and spillage was reported to occur in quantities ranging from 100 to 200 gallons per year. Over the period of 10 years, it is estimated that 1,000 to 2,000 gallons of waste oils and solvents were discharged on to the ground in this area.

Adjacent to this site, a spill of about 300 gallons of JP-4 fuel occurred in 1982. The spill occurred on an area used for storage of vehicles, now referred to as Antenna Hill. It was reported that the Base Fire Department responded, foamed the area, and excavated the contaminated soil. However, it is possible that some of the JP-4 migrated down into the soil.

4.6.6 Heating Plant - Site No. 6

The heating plant (Building #212) supplies heat in the form of hot water to 14 buildings on the ARF. Two furnaces in the building produce approximately 34,000,000 BTU/hour.

The plant is operated by a private contractor on a 3-year contract. The current contractor has been in charge of the building for approximately two years. No records were available on historic operations by previous contractors.

The plant burns #6 fuel oil at the rate of approximately 320,000 gallons per year. A small amount (approximately 500 gallons per year) of #2 fuel oil is used to fire up the furnaces and purge the fuel lines after a burn period. Chemicals used at the plant include small

amounts (approximately 20 gallons per year) of solvents such as petroleum naptha, corrosion inhibitors (e.g. Acidine), and water softening chemicals used to pretreat water heated in the furnaces (OS15G - liquid oxygen scavenger, BSC-30G - alkalinity control agent, and sludge dispersant).

Two, #6 fuel oil storage tanks are located in an open area east of the building. The older #6 fuel oil storage tank (#221) has a capacity of 20,000 gallons. A new 15,000-gallon tank was installed in summer of 1983. Both are installed above ground and have containment walls, but no liners to prevent downward infiltration. In early 1984, Tank #221 was overtopped, and 20 to 30 gallons of #6 fuel oil were spilled on the ground below the tank. At the time of the WESTON site visit, no action had been taken to clean up this spill.

The #2 fuel oil is stored in a 600-gallon tank on the west side of Building #212. Other chemicals are stored in miscellaneous drums in and around the building. Based on observed handling practices during the site visit, there is a possibility that spills or leaks of other compounds besides #6 fuel oil could have occurred.

4.6.7 Old Well House - Site No. 7

The old well house is a small building (#205) located on the northern corner of the ARF property built over Well AF-2. This building housed the well pump in the past and is underlain in part by a valve pit housing the top of the well casing, the T-connection to the main distribution lines, and valves for these lines. Use of the well was discontinued in 1962 and the pump was removed.

The well casing was flanged off above ground surface in the well house. However, the floor of the well house is open to the valve pit below through a hole around the well casing. The valve pit generally has some water ponded in it, and the type and integrity of the seal between this pit and the well casing could not be ascertained.

The building has been used since 1962 by Base Civil Engineering for storage of unused and partially used cans of paint, paint thinner, lacquer thinner and paint wastes. Since 1983, it has become a designated "waste accumulation point". Materials in the well house include approximately 30, one-gallon cans of paint and paint thinner inside the building. There were ten, one-gallon and five-gallon cans outside the building, including two full cans labeled 'Toluene- Technical', and miscellaneous five-gallon cans of unknown materials.



SECTION 5

CONCLUSIONS

5.1 INTRODUCTION

This section summarizes the conclusions reached relative to the need for further confirmation studies at each of the seven sites discussed in the previous section. The seven sites are listed in Table 5-1 in order of descending priority, based on the Hazard Assessment Rating Methodology (HARM) scores. The HARM methodology is described in Appendix D. Rating forms for each site are presented in Appendix E. The objective of the Phase I Study is to develop sufficient evidence to justify further confirmation studies in Phase II.

All seven sites identified were rated as having sufficient reason to justify further confirmation analysis. A summary of the conclusions for each site is presented in the subsections below.

5.2 POL AREA - SITE NO. 1

Sufficient evidence exists that a significant volume (8,000 to 10,000 gallons) of JP-4 has been discharged in the past and may have migrated into the water table beneath the POL area.

In addition, there may be smaller amounts of 1100 aviation oil, MOGAS and #6 furnace fuel in the ground from undocumented spills or leaks associated with past

TABLE 5-1

SUMMARY OF WASTE TYPES AND HARM SCORES
FOR CONFIRMATION SITES AT WILLOW GROVE ARF

Site Number	Site Name	Waste Type	HARM Score
1	POL Area	JP-4 Fuel JP-4 Fuel Sludge 1100 Aviation Fuel	82
2	Open Waste Storage Area #42	Engine Oil Hydraulic Fluid Solvents (PD-680, 1,1,1-Tri-chloroethane, Lacquer Thinner, Paint Stripper) Methanol De-Icing Fluid (Ethylene Glycol)	79
3	Ponding Basin	JP-4 Fuel Other Fuel Oils Solvents	70
4	Washrack Area	Super II Detergent Solvents (PD-680, Dexyl) Paint Strippers (Lacquer and Enamel Stripper, MEK)	69
5	Building #330 Waste Oil Storage Area	Engine Oils Hydraulic Fluids Solvents	69



TABLE 5-1
(Con't)

**SUMMARY OF WASTE TYPES AND HARM SCORES
FOR CONFIRMATION SITES AT WILLOW GROVE ARF**

Site Number	Site Name	Waste Type	HARM Score
6	Heating Plant	#6 Fuel Oil #2 Fuel Oil Solvents (Petroleum Naptha) Corrosion Inhibitor (Acidine) Liquid Oxygen Scavenger Alkalinity Control Agent	66
7	Old Well House	Paint and Paint Wastes Paint Thinners Solvents (Toluene)	57

POL operations. The potential for migration is obviously high, since the water table is shallow. During remodeling of Tank #207, a special drain had to be put in to drain off seasonally high groundwater from beneath the tank and fuel has been observed in monitor wells and in oily seeps on the edge of the ponding basin. Since the full extent of the fuel plume and the degree of contamination of the underlying bedrock aquifer are not known at this time, the POL site is recommended for further confirmation. Specific recommendations for a confirmation study at this site are given in Section 6.

5.3 OPEN STORAGE AREA #42 - SITE NO. 2

Although it is difficult to quantify the amount of spillage and leakage of waste oils and other hazardous materials at the Open Storage Area #42, the evidence is strong that contamination has occurred at this site.

The potential exists for contaminant migration to both surface and groundwater from the site. The landing mat covering the ground does not constitute a barrier to infiltration, so that spilled materials can directly percolate the ground. However, the mat does offer some protection from surface erosion. The ground slopes to the northeast, allowing runoff to flow across Andrews Street into the perimeter ditch leading to the ponding basins, either by overland flow or through culverts at the northeast corner of the site. Assuming that the water table is approximately coincident with the bedrock surface, depth to groundwater beneath the site is about 12 feet. Surface soils at the site are moderately permeable Lawrenceville silt loam, indicating that

contaminants could have migrated downward to the water table. Recommendations for confirmation analysis at this site are presented in Chapter 6.

5.4 PONDING BASIN - SITE NO. 3

Sufficient evidence exists that the ponding basin has served as a receptacle of JP-4 waste oils and solvents, which have been washed off in runoff from various areas of the ARF. Although the amount of contamination is difficult to quantify, the use of the ponding basin as a stormwater receptacle for 26 years strongly suggests that a sufficient amount of contamination exists to warrant further confirmation analysis.

The potential for migration from the ponding basin exists through both surface and groundwater. According to Base Civil Engineering, the basin is excavated into bedrock well below the water table, and will partially refill with groundwater seepage if it is drained. It can, therefore, be considered a good hydraulic connection with the underlying aquifer and subject to contaminant exchange with that aquifer. For this reason, it is concluded that the ponding basin should be a site for confirmation study in Phase II. Recommendations for a confirmation study for this site are presented in Section 6.

5.5 WASHRACK AREA - SITE NO. 4

It has been determined that sufficient quantities of solvents and paint strippers were discharged onto the ground at this site over the past 26 years from aircraft and parts cleaning activities.

Based on the high likelihood of direct discharge to the subsurface, the washrack area, including the paint sheds and adjacent open area, are recommended for confirmation study. In addition to the potential for migration through the groundwater pathway, there is evidence of both direct runoff and seepage from this area to a drainage ditch immediately adjacent on two sides to the southeast and northeast. This ditch is relatively deep (two to three feet below ground surface) and may intercept seasonal high groundwater. An oily seep was observed on the bank of the ditch adjacent to the washrack just upstream from Eglin Street.

5.6 BUILDING #330 WASTE OIL STORAGE AREA - SITE NO. 5

Visual observation and interviews with ARF personnel strongly suggest that oil contamination occurred at this site over a ten-year period (1970 to 1980). The soils are moderately well drained in this area and groundwater contamination could have occurred. It is estimated that the water table is 10 to 12 feet below the ground surface at the site. Recommendations for further confirmation are given in Section 6.

5.7 HEATING PLANT - SITE NO. 6

Based on visual observation, it appears that an undetermined quantity of #6 fuel oil and perhaps hazardous chemicals were spilled or discharged to the ground at this site.

There is potential for contaminant migration from the site through either the storm drain into the surface water system or through the subsurface to groundwater.

The static water table is estimated to be coincident with the bedrock surface at approximately eight feet below ground surface. Due to the proximity of the site to supply well AF-1, (approximately 200 feet), groundwater levels, flow directions and flow velocity are likely to be strongly influenced by pumping from that well. The site is recommended for further confirmation as discussed in Section 6.

5.8 OLD WELL HOUSE (BUILDING #205) - SITE NO. 7

It is not possible to document how much, if any, hazardous material have been spilled or leaked in the vicinity of Building #205. However, observations of the site indicated that spills may have occurred. The potential for contaminant migration from the site is high because of proximity to the base boundary and because many products spilled in or near the building would most likely end up in the valve pit. When the valve pit floods, it drains through an outlet pipe into the perimeter ditch, which appears to spill out onto adjacent (off-base) property during high-flow events. During periods of low or no runoff, standing water in the valve pit may seep into the ground, and could run down the well casing, providing a direct connection to the bedrock aquifer, if the casing seal is inadequate. A confirmation study is recommended at this site and is presented in Section 6.

SECTION 6**RECOMMENDATIONS****6.1 INTRODUCTION**

The following recommendations are made for work to be performed in Phase II (Problem Confirmation). The recommended actions are generally one-time sampling and analytical programs. They are designed on a site-by-site basis to verify the presence or absence of contamination at a site, and to further assess the potential for adverse environmental impact from contamination should it be present at a site. The recommended actions are summarized in Table 6-1.

6.2 POL AREA - SITE NO. 1

The POL area has had confirmed contamination through loss of JP-4 to the subsurface from a leak in Tank #207. To determine the current areal extent of the plume of fuel between the POL area and the ponding basin, it is recommended that three soil borings be drilled to bedrock in a line approximately parallel to Langley Street, between the west fence and the existing monitor wells. Three additional soil borings are recommended to confirm presence or absence of contamination in soil: one beneath or near the fuel oil tank #222; one next to the underground waste fuel storage tank; and one just outside and immediately adjacent to the fence surrounding the reported fuel sludge burial

TABLE 6-1

**RECOMMENDED PHASE II SAMPLING PROGRAM
WILLOW GROVE ARF**

Site No.	Site Name	Harm Score	Recommended Phase II Sampling Program				
			No. of Soil Borings ¹	No. of Monitor Wells ²	Maximum		No. of Surface Water
					No. of Soil/Sed Samples ³	No. of GW Samples ⁴	
1	POL Area	82	6	1	18	5	—
2	Open Storage Area No. 42	79	6	4	18	4	—
3	Ponding Basin	70	—	—	6	3 (seeps)	6
4	Washrack Area	69	3	3	14	5 (3 wells, 2 seeps)	—
5	Bldg. 330 Waste Oil Storage Area	69	—	1	8 (5 hand auger)	1	—
6	Heating Plant	66	—	—	5 (all hand auger)	—	—
7	Old Well House	57	—	—	1	2	1
TOTALS			15	9	71	20*	7

* 20 = 2 from AF-2, 4 from existing monitor wells, 9 from new monitor wells, 5 from seeps

NOTES:

- ¹ Soil borings refer to hollow stem auger holes not finished as monitor wells.
- ² All monitor wells to be drilled 20 feet into bedrock, screened above seasonal high water and sand packed.
- ³ Sediment samples to be preserved for analysis to be determined by use of on-site OVA.
- ⁴ A seep is defined as an area of ground where water or other liquid oozes from the earth; water collected from a seep is treated as groundwater.

area. (Note: drilling directly over the area may be impossible due to the steep grade on the new tank berm.) Sampling intervals and protocols are described in Section 6.9.

To confirm presence or absence of contamination in groundwater, it is recommended that the four existing monitor wells be sounded for depth and sampled. Assuming that these wells were completed above bedrock, it is recommended that one additional well be drilled into bedrock following the specifications outlined above. The location will be chosen in the presumed downgradient direction based on existing information, study of aerial photography, and the results of drilling around Open Storage Area #42. Minimum well construction requirements are summarized in Table 6-2 and illustrated diagrammatically in Figure 6-1.

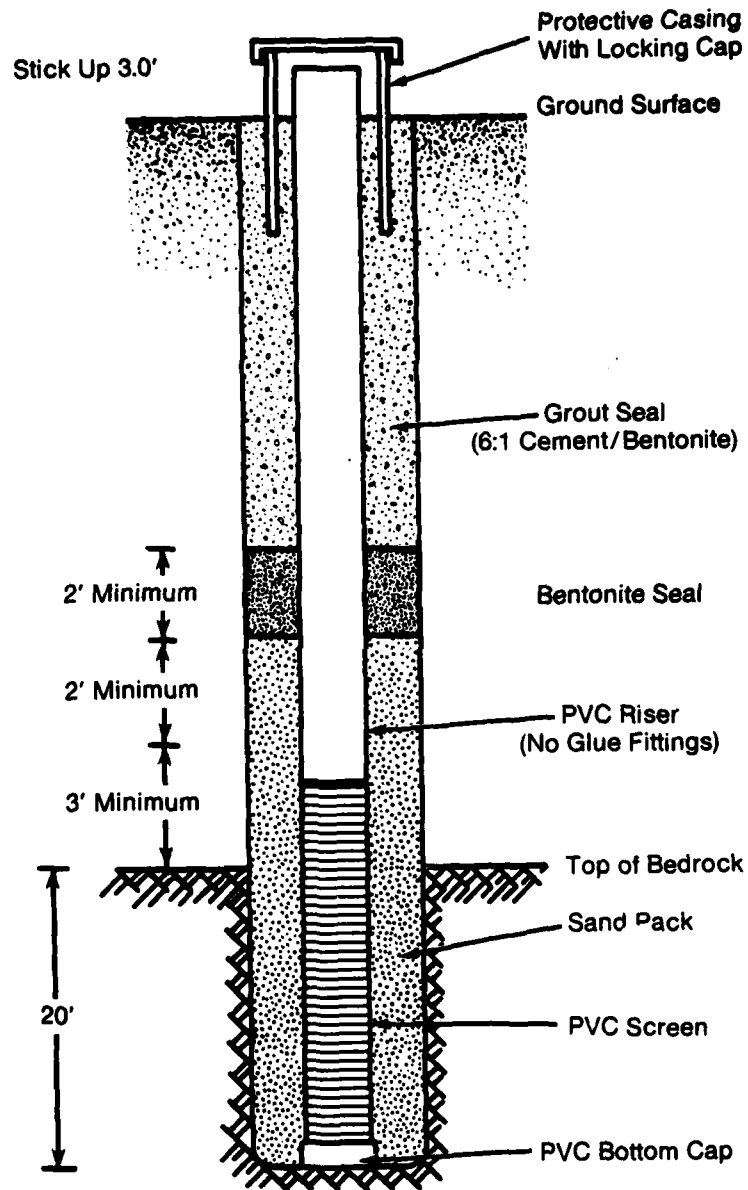
6.3 OPEN STORAGE AREA #42 - SITE NO. 2

This site has a potential for resulting in an adverse environmental impact, with subsurface percolation through soil into the bedrock aquifer the most obvious and persistent pathway.

To adequately evaluate presence or absence of contamination in subsurface sediments, it is recommended that six soil borings be drilled to bedrock (approximately 12 feet) and be sampled at three intervals (0 to 2 feet, 4 to 6 feet, and 10 to 12 feet, or at the bedrock interface). The subsurface sediment samples to be preserved for analysis will be selected in the field based on measurements of soil vapor made with a portable Organic Vapor Analyzer (OVA) or equivalent field instrument. Every sample exhibiting OVA readings above background levels should be preserved, within a range of a minimum

TABLE 6-2
MINIMUM WELL CONSTRUCTION REQUIREMENTS

Item	Description
Casing	PVC with nonglue fittings
Minimum casing diameter	Four inches
Screen	PVC wound with nonglue connectors and bottom cap
Top of screen	3 feet above the water table
Gravel pack	2 feet above top of the screen
Bentonite seal	A 2-foot bentonite seal should be placed above the gravel pack.
Grout	6 to 1 bentonite/cement mix to 2 feet below surface. Grout emplaced with a grout pipe. Grout pumped through pipe to the bottom of the open annulus (above the seal).
Protective cover	5-foot length of black iron pipe extending 3 feet above the ground surface and set in cement grout. Pipe diameter must be at least 2 inches greater than casing diameter.
Cap	A secure locking cap should be provided.
Survey	Locations and elevations of all wells should be surveyed.



of six (one from each boring) and a maximum of 18. Parameters for analysis are listed in Table 6-3. It is recommended that the borings be drilled following a grid pattern within the fenced portion of the storage area.

To adequately assess presence or absence of contamination in groundwater, it is recommended that four wells be installed on the perimeters of the #42 Open Storage Area. The wells should penetrate 20 feet into bedrock and be screened above the water table to ensure that the upper portion of the shallow aquifer, including any floating product on top of the water table, is sampled. Minimum well construction requirements are listed in Table 6-2. Wells should be located approximately at 90° from each other around the site, following the orientation of dip and strike, or lineation evident in an aerial photography study to be performed prior to drilling. One monitor well should be placed next to Bolling Street, between Open Storage Area #42 and the POL area.

6.4 PONDING BASIN - SITE NO. 3

This site has a high potential for environmental impact due to its function as a collection point for surface discharge from the facility, and its connection with the underlying bedrock aquifer.

To adequately assess presence or absence of contamination, it is recommended that the pond bottom be sampled at three locations, with a sample of bottom sediment and a sample of water one foot off the bottom to be collected at each location. In addition, it is recommended that three sidewall seeps be sampled, with a sediment and a water sample to be collected from each. The surface discharge from the pond should also be

TABLE 6-3**RECOMMENDED LIST OF ANALYTICAL PARAMETERS
FOR SELECTED SITES AT WILLOW GROVE ARF****Sampled Media:**

- Soil from surface, collected by hand auger
- Subsurface soil and sediment, collected by hollow stem auger rig
- Groundwater from monitoring wells
- Surface water from ponding areas

Recommended Analytical Parameters:

- Total Organic Carbon (TOC)
- Total Halogenated Hydrocarbons (TOX)
- Oils and Greases
- VOA's Including Xylene
- Temperature (Field Determination on Water Only)
- pH (Field Determination on Water Only)
- Specific Conductance (Field Determination on Water Only)

sampled three times, approximately at one-week intervals, and preferably under differing flow rate conditions. It will be necessary to secure the cooperation of the U.S. Navy Office of Public Works, especially for the seep sampling, so that the pond level can be adjusted to an appropriate working elevation. The parameters listed in Table 6-3 should be analyzed.

6.5 WASHRACK AREA - SITE NO. 4

This site has a high potential for environmental impact due to the possibility of direct discharge from the washrack effluent treatment system into the bedrock aquifer, as well as possible surface spills in the vicinity of Buildings #215 and #223.

To adequately assess the presence or absence of contamination in subsurface sediments, it is recommended that six soil borings be drilled to bedrock (estimated depth 6 feet), and sediment samples collected from 0 to 2 feet and from 4 to 6 feet (or at the bedrock interface). Furthermore, it is recommended that three of these borings be continued into bedrock and finished as monitor wells following the specifications described in Table 6-2.

To evaluate the potential for contaminant migration along a surface water pathway, it is recommended that one sediment and one water sample be collected at two locations in the ditch bordering the area on the south and east sides. If seeps are present in the sidewall of the ditch, sampling locations should correspond to these seeps.

6.6 BUILDING #330 WASTE OIL STORAGE AREA - SITE NO. 5

This site has potential for environmental impact due to percolation of waste oils and possibly solvents into the ground.

To assess the presence or absence and surface extent of contamination, it is recommended that five samples be collected with a hand auger from a depth of 0 to 2 feet following the protocol described above. At least one of these samples should be collected from the JP-4 spill area on antenna hill just southeast of Building #330. In addition, it is recommended that three sediment samples be collected from an auger boring to bedrock drilled in the approximate center of the area of waste oil spillage. This boring should be continued 20 feet into bedrock and finished as a monitor well following the specifications outlined in Table 6-2.

6.7 HEATING PLANT - SITE NO. 6

This site has potential for environmental impact due to a confirmed spill of #6 fuel oil and observed chemical handling practices.

To adequately assess the presence or absence of contamination below Tank #221, the site of the #6 fuel oil spill, it is recommended that a hand auger be used to collect two sediment samples from depths between 0 and 4 feet inside the tank containment area. Visual observation and OVA measurements should be used to define the extent of vertical migration and identify samples for analysis. It is not recommended that an auger rig be used at this site due to the inaccessibility of the area beneath Tank #221 and around the heating plant in

general. Based on the viscosity of #6 fuel oil, its migration rate through soil is estimated to be very slow. Deeper sampling of sediment may be warranted in a later phase, however, should the degree of contamination identified during the recommended Phase II investigation turn out to be extensive.

In addition, it is recommended that three more soil samples be collected outside of the tank containment area, adjacent to the heating plant building in areas of suspected spills. The sampling protocol as described in Table 6-1 should be used.

6.8 OLD WELL HOUSE - SITE NO. 7

This site has a potential for environmental impact through contaminant migration along both surface water and groundwater pathways, but the presence of contamination is presently not confirmed. To adequately assess the presence or absence of contamination, and identify the most likely pathway(s), it is recommended that one sample be collected from the water ponded in the valve pit, and that two groundwater samples be collected from the production well (AF-2) itself, one from the stagnant casing water and one after purging three well volumes. In addition, it is recommended that one sediment sample be collected from the area of surface water ponding immediately north of the valve pit (on the northeast corner of the old well house).

6.9 GENERAL CONFIRMATION RECOMMENDATIONS

6.9.1 Soil Borings and Well Installation

It is recommended that soil borings be drilled with a truck or trailer-mounted hollow stem auger rig, and

samples collected with a split spoon sampler following the Standard Penetration Test (ASTM D-1586). This will ensure collection of representative samples from known depths. Drilling into bedrock should be performed by a rotary or rock hammer rig, and the hole should be thoroughly developed before completion. The recommended depth of 20 feet into bedrock has been chosen to ensure adequate monitoring of the upper portion of the bedrock aquifer without unnecessary risk of contaminating lower zones. The well completion specifications outlined in Table 6-2 have been designed primarily to ensure that the well is in good hydraulic connection with the aquifer, that product floating on the water table can enter the well freely, and that the casing is sealed to prevent surface water from running down to the screened area.

6.9.2 Analytical Parameters

Recommended analytical parameters for the Phase II confirmation study sampling are listed in Table 6-3. They are the same for water and sediment, except for field determinations of temperature, pH, and specific conductance to be performed on water only. They include TOC and TOX, used to screen samples for organic contamination; oils and greases, used to screen samples for contamination with hydrocarbons; and volatile organic analytes (VOA) including xylene, to identify specific solvents, industrial chemical compounds, and soluble components of fuels that may be present. There is no evidence of a need for sampling heavy metals at this time, although these might be included in an expanded Phase II sampling program.

Further field investigation at any of these sites may be warranted based on the results of the Problem Confirmation Study, and could be performed as a Quantification Stage in the Phase II Investigation.

The recommendations contained in this report are designed primarily to yield sufficient information on presence or absence of suspected contamination. At those sites where the presence of contamination is confirmed, it may be necessary to perform additional soil sampling, install new wells, and modify or expand the list of analytical parameters to achieve adequate definition and quantification of the extent of contamination.



APPENDIX A

RESUMES OF THE WESTON TEAM



RAYMOND W. KANE, P.E.

Registration

Registered Professional Engineer in Pennsylvania

Fields of Competence

Environmental management and regulatory compliance; energy facility siting; oil, gas and shale technology; water resource planning; hazardous waste management; regional planning; environmental impact assessment; management consulting; strategic planning.

Experience Summary

Twelve years in a variety of energy/environmental projects for large industrial firms, and Federal and state government clients. Manager of large complex interdisciplinary studies for petroleum, and chemical industries. Program manager for statewide power plant siting study and oil, gas and shale technology research and development activities on the Federal level.

Conducted numerous environmental audits and regulatory compliance reviews at industrial facilities. Conducted several water resource planning and economic base studies. Conducted industrial hazardous waste planning and engineering evaluations.

Credentials

B.S. - Civil Engineering - Villanova University (1967)

M.S. - Civil Engineering - (Water Resources) Villanova University (1976)

Tau Beta Pi

Water Pollution Control Federation

Society of American Military Engineers

American Defense Preparedness Association

Commander - U.S. Naval Reserve, Civil Engineer Corps

Employment History

1981-Present	WESTON
1978-1981	Booz-Allen & Hamilton Principal
1975-1978	WESTON
1973-1975	McCormick, Taylor & Associates
1972-1973	Kappa Systems, Inc.



RAYMOND W. KANE, P.E.
(continued)

1971-1972 Upper Darby Township
 (Pennsylvania)

1967-1971 Submarine Force, U.S.
 Navy

Key Projects

Project Director of Navy Phase I Initial Assessment Study for Portsmouth Naval Shipyard and Brunswick Naval Air Station. Conducted record searches and field investigations to determine existence of any past hazardous waste disposal sites. Developed recommendations for Phase 2 Confirmation and Quantification Study.

Participated in three of WESTON's previous confirmation studies under WESTON's installation restoration contracts for the Air Force and the Army.

Principal Investigator on a hazardous waste storage needs on four Navy installations around the country.

Participated in five other hazardous waste site investigations for EPA and other industrial clients, all of which included hydrogeological investigations, soil, groundwater sampling and analysis, and remedial concept engineering.

Project manager for environmental audit and regulatory compliance review for Occidental Petroleum Corporation. Conducted reviews of over 100 chemical, petroleum and coal preparation facilities. Determined true costs of environmental compliance activities and corporate liability for 3-year period. Study

was in response to SEC consent agreement. As a follow-on also developed an Assessment Program Guidance Document (APGD) to help corporate staff set up programs, policies and procedures to ensure environmental related liabilities and exposure are minimized.

Project Director for "Development of Environmental Audit Program" for the National Institutes of Health. Responsible for establishment of audit protocols and procedures to ensure compliance with Federal, state and local environmental requirements for the main campus of NIH and field facilities around the country.

Project Manager for coal-fired power plant siting study in Western Maryland. Served as program integrator, managing the technical work of several subcontractors. Identified exclusionary and discretionary screening criteria and determined best sites for siting of power plant using state MAGI (environmental data base) system. Participated in Public Involvement Program through public workshops and meetings. Reservoir siting and coal cleaning facility siting studies were also a part of this large complex project.

Project Manager for large oil, gas, and shale technology R&D project for Department of Energy. Conducted a variety of technical resource characterization studies, market studies, strategic planning and environmental assessment evaluations for DOE's program offices. Technologies evaluated included above-ground and modified in situ oil shale retorting and enhanced oil recovery and enhanced gas recovery. Coordination with Bartellsville Energy Technology Center (BETC) staff was a major part of this project.

RAYMOND W. KANE, P.E.
(continued)

Project Manager - New York City, Department of Environmental Protection. Responsible for environmental assessment of city-wide sludge management facility plan. Work includes site selection criteria and screening and development of baseline information and impact assessments for a range of land-based alternatives including composting, land application, co-incineration, co-disposal and landfilling.

Project Manager - Pennsylvania Department of Transportation. Responsibilities included regional planning and development of an EIS for 17 miles of a 4-lane interstate highway project and coordination of all study elements. Public participation and client relations were prime management responsibilities, in addition to the technical responsibility for water resources assessment.

Project Manager - Confidential Industrial Client. Determination of potential development constraints for expansion of facilities for a major industrial client, involving investigations of: 1) zoning regulations; 2) municipal services; 3) environmental constraints; 4) traffic transportation constraints.

Project Manager - Jacksonville District Corps of Engineers. Responsibility included: coordination and management of \$150,000 multi-disciplinary study of geologic and biologic resources, land use, soils and other existing natural resources; projection of population and other economic parameters to the year 2030 and forecasts of water demand and

wastewater generation; LANDSAT and other multi-spectral imagery to develop certain types of graphic overlays showing wetlands and other transitional zones.

Project Director for hydrogeologic investigation of TCE contamination for industrial client in New Jersey. Conducted wastewater sampling and analysis, pump tests and groundwater modeling to determine cause and effect relationship of contamination.

Project Manager - Vicksburg District Corps of Engineers. Responsible for the coordination and management of study geared to the projection of population, employment earnings, value added, income, industrial growth, and agricultural production for a 26-county region in northwest Mississippi.

Publications

Kane, R.W., "Water Resources Impacts of Synthetic Fuels Development in the West," 1981.

Kane, R.W., Cahill, L.W., Burns, H.B., "Energy Choices and Environmental Constraints, 1979.

Kane, R.W., "What Constitutes a Good Corporate Environmental Management and Regulatory Compliance Program?," 1981

Kane, R.W., Emig, D., "DoD's Superfund Program," 1983.

Kane, R.W., Gertz, S.G., "Hazardous Waste - Corporate Risk or Corporate Profit?," 1982.

ALISON L. DUNN

Fields of Competence

Groundwater flow sytem analysis and numerical modelling; groundwater contamination assessment and remediation; hydrogeologic evaluation of solid and hazardous waste sites; water supply and recovery well design and testing; monitor well network design and implementation; sampling of soil and water for conventional and hazardous chemical compounds.

Experience Summary

Three years of experience as field hydrogeologist and project geologist in industrial and hazardous waste disposal site investigations, including two Superfund sites, and in inventories and assessments of various classes of injection wells.

Three years of graduate research in hydraulic properties of shales and mudstones, watershed hydrology, and coastal hydrogeology, including practical applications of numerical groundwater flow models.

Credentials

B.A., Geology — Mount Holyoke College (1976)

M.S., Hydrogeology — University of Arizona (1981)

National Water Well Association, Technical Division

American Geophysical Union, Hydrology Division

Employment History

1984-Present	WESTON
1981-1984	SMC Martin Inc. Valley Forge, Pennsylvania
1978-1981	University of Arizona Department of Hydrology
1978 (summer)	Office of the State Geologist Montpelier, Vermont

Key Projects

Field evaluation of potential surface water and groundwater contamination at two Air Force Bases in California, including monitor well installation and sample collection, analysis of the hydrogeologic and chemical data.

Field evaluation of an underground fuel leak at an Air Force Base on the Gulf Coast, Florida, including plume delineation, source identification, water table map preparation and interpretation, and evaluation of tidal effects in contaminant migration.

ALISON L. DUNN
(continued)

Installation Restoration Program Phase I investigation of an Air Reserve facility in the mid-atlantic region, including site visit, interviews and file searches, compilation and interpretation of hydrogeologic data, and preparation of recommendations for Phase II investigation.

Site assessment and remediation at an uncontrolled hazardous waste disposal site in New Jersey, including field sampling of highly contaminated groundwater and soils, conceptual development of site remediation measures, and testing of remedial measures on a computer groundwater flow model.

Hydrogeologic investigation of a 50 acre site for impact of past electronic components manufacturing operations on ground and surface water.

Evaluation of the effect of placing an innovating top seal for closure of a 25 acre municipal landfill, including analysis of long-term hydrogeologic and geochemical conditions.

Site assessment and remediation at an uncontrolled hazardous waste disposal site in Ohio, including a metal detector survey for buried drums, soil sampling, drilling and well construction supervision, well logging, data analysis.

Evaluation of surface seepage from a 3-acre wastewater lagoon, including water level monitoring and a detailed water budget.

Publications

"Trichloroethylene Occurrence and Ground-Water Restoration in Highly Anisotropic Bedrock: A Case Study," co-authored, with David L. Kraus. Proceedings of the Third National Symposium and Exposition on Aquifer Restoration and Groundwater Monitoring, National Water Well Association, Columbus, OH, 1983.

"Leachate Quality Improvements after Top Sealing," co-authored with W.W. Beck, Jr. and G.H. Enrich. Proceedings of the 8th Annual U.S. EPA MERL/SHWRD Conference, 1982.

"The Impact of Top-Sealing on the Windham, Connecticut Landfill," co-authored with R.M. Schuller and W.W. Beck, Jr. Proceedings of the 9th Annual U.S. EPA MERL/SHWRD Conference, 1983.

"Preliminary Assessment of the Hydrologic Environment of Klamath Marsh, Oregon," co-authored with M.E. Norvelle, S.L. Vierek, and S. Ince. NADSAT Project Completion Report No. 31, 71 p. 1981. Office of Arid Land Studies, University of Arizona.

ALISON L. DUNN
(continued)

"A Study of Salinity in Effluent Lakes, Puerto Penasco, Sonora, Mexico," Hydrology and Water Resources in Arizona and the Southwest, American Water Resources Association, Arizona Section, 1981.

"Analysis of a Saline Ground-Water Flow System in Puerto Penasco, Sonora, Mex-

ico," presented to the Cordilleran Section Meeting of the Geological Society of America, March 1981.

"A Bibliography of Vermont Geology," compiled with Charles Ratte and Diane Vanacek, Office of the State Geologist, Montpelier, Vermont, 1980.

MICHAEL F. COIA

Fields of Competence

Solid and hazardous waste management; hazardous waste site remedial actions; solid waste collection, storage and disposal, and resource recovery unit operations.

Experience Summary

Three years of civil and environmental engineering experience in the fields of hazardous and solid waste management including: industrial and hazardous waste treatment, storage and disposal technologies; hazardous waste site remedial action alternatives; the engineering responses of clay soils to the presence of hazardous waste chemicals; modelling and evaluation of complex cover systems for application at hazardous waste disposal facilities; radioactive waste disposal strategies; resource recovery and refuse to energy technologies.

Credentials

B.S., Civil Engineering -- Duke University (1980), Cum Laude

M.S., Environmental Engineering -- Duke University (1981)

Chi Epsilon

Employment History

1981-Present WESTON

5133A

1980-1981

Duke University

Key Projects

A Team Engineer on four Phase I studies including the U.S. Air Force Academy; Project Engineer on a project to determine hazardous waste storage needs at DPDO facilities on various Navy installations.

Served as Project Engineer for the following WESTON hazardous waste projects:

- . Development of a remedial action clean-up program for Bruin Lagoon, Pennsylvania for EPA under "Superfund" for Bruin Lagoon, a 3-acre acidic oil sludge lagoon located in western Pennsylvania. Prepared the design of a complex cover system, groundwater controls, and sludge dewatering/stabilization methodology for an in situ stabilization of the oily sludge waste at Bruin Lagoon. Prepared contractor bid specifications.
- . Evaluation of clean-up scenarios at an existing industrial complex of over 2,000 acres in California contaminating the soil and groundwater quality through storage, spillage, and deep-well injection of organic and halogenated compounds.

- . Development of regulatory and technology guidelines for the closure of inactive explosive waste lagoons at over 40 U.S. Army installations. Analyzed the waste lagoon characteristics and installation area characteristics and installation area characteristics, as well as the Federal and state regulatory requirements for closure of inactive land disposal facilities. Evaluated in-place closure technologies for application with groundwater isolation and pumping, surface soil capping, and explosive waste desensitization.
- . Assessment of available hazardous waste management technologies for implementation on a provincewide scale for Ontario, Canada. Analyzed appropriate chemical and physical treatment strategies, incineration technologies, fixation/stabilization approaches, and ultimate disposal alternatives for application to Ontario's industrial waste streams.
- . Evaluation of potential remedial action clean-up strategies under Superfund for Matthews Electroplating, a site where soil and groundwater contamination resulted from chromium plating operations. Conducted the site characterization field work, environmental sampling, and geologic soils investigations. Prepared the engineering feasibility study for the selected remedial action alternative.
- . Evaluation of a municipally-operated refuse-to-energy resource recovery system for Salem County, New Jersey.

Prepared the system design based on Countywide waste stream characterization, identification of potential energy markets, evaluation of incineration technologies, and cost-effective analysis.

- . Development of a remedial action cleanup program at a major industrial site on Lake Michigan where massive PCB spills and discharges have contaminated soil and surface water quality.

As a Research Assistant at Duke University, supervised the following projects in solid, hazardous, and radioactive waste management:

- . Analysis of permeability rate and other structural alterations in clays and clay soils when exposed to industrial and hazardous waste leachates in completion of a Master's degree thesis in environmental engineering.
- . Prepared the methodology for evaluation of a potential low-level radioactive waste disposal facility in Research Triangle Park, North Carolina.
- . Evaluation of resource recovery applications in North Carolina, including the potential use of a shredding operation at the Durham sanitary landfill.

Publications

"The Effect of Electroplating Wastes Upon Clay As An Impermeable Boundary to Leaching," M.S. Thesis by M.F. Coia.

MICHAEL F. COIA
(continued)

"The Leaching of Electroplating Wastes Through Clay Liners," by M.F. Coia, J.J. Peirce, and P.A. Vesilind. Presented at the 1981 AIChE 74th National Conference.

"Bruin Lagoon: Remedial Clean-up of Hazardous Waste Sites Under Superfund," by M.F. Coia and J.W. Thorsen. Presented at the 1982 Mid-Atlantic Industrial Waste Conference.

"Remedial Superfund Actions: Procedures and Results," by J.W. Thorsen and M.F. Coia. Presented at the 1982 Na-

tional Conference of ASCE, Environmental Engineering Division.

"Remedial Actions at Industrial Waste Sites: A Case History, Bruin Lagoon," by M.F. Coia. Presented at the 1982 Engineering Foundation Conference: Industry Response to the Hazardous Waste Challenge.

"In-Place Stabilization and Closure of Oily Sludge Lagoons," by A.A. Metry, M.F. Coia, M.H. Corbin, and A.L. Lenthe. Presented at 1983 WPCAP Technical Conference.



NAME: Jennifer Kauffman
Roy F. Weston, Inc.

ASSIGNMENT/LEVEL: Technical Writer/Editor
Level 2

EDUCATION:

B.A., Land Use and Regional Planning - Bowling Green State University (1977)

Master's of Regional Planning - University of Michigan (1979)

EXPERIENCE SUMMARY:

- Five years experience in consulting planning and engineering fields as project planner, project coordinator and technical writer and editor.
- Edited workbooks, and developed and implemented promotional programs for hazardous/solid waste, environmental and energy conservation workshops, presentations, and seminars.

KEY PROJECTS:

Co-author and technical editor of more than a dozen small-scale hydroelectric feasibility studies. Prepared environmental impact assessments, analyzed hydraulic and hydrologic data and researched legal and institutional constraints to development. Prepared FERC preliminary permit, exemption, and license applications.

Edited workbooks and prepared promotional materials for one day seminars on energy conservation in municipal water and wastewater systems, and energy conservation in commercial lodging facilities.

Assistant planner and author for preparation of a coastal zone management plan for the St. Clair Flats, a sensitive freshwater delta in Lake St. Clair near Detroit. Collected, analyzed, and mapped natural resource and cultural data. Assisted in development and analysis of alternate management scenarios, preparation of land management and acquisition priorities plans, and report writing.

Inventoried data sources and conducted preliminary assessment of state hydroelectric development potential for Ohio Department of Energy.



Researched and authored environmental assessment for proposed modifications and expansion of the wastewater treatment facility at K. I. Sawyer Air Force Base, Michigan.

Evaluated state policies and procedures governing the issuance of dredge, fill, and construction permits in inland lakes and streams and Great Lakes bottomlands in Michigan.

Researched and participated in preparation of a number of coastal zone management, recreation and community master plans. Conducted facility inventories, natural resource capability analyses and impact assessments. Collected and analyzed data, developed and implemented surveys, researched regulatory, financial and technical programs, and prepared reports.

EMPLOYMENT HISTORY:

1983 - Present	WESTON
1979 - 1983	Ayres, Lewis, Norris & May, Inc.
1978 - 1979	University of Michigan Coastal Zone Laboratory

PUBLICATIONS, AWARDS, CREDENTIALS:

Project Planner and principal author of comprehensive solid waste management plans for Bay and Midland Counties in Michigan. Analyzed quantity and composition of waste stream. Evaluated feasibility and assessed impacts of management alternatives, including landfilling, energy recovery, recycling and composting. Developed landfill capability maps and management/implementation strategies.

Organized, administered, and promoted a series of workshops on energy conservation in municipal water and wastewater systems in Pennsylvania.

"Multiple Use Issues and Reactivation of Former Hydro Plants." Presented at WATERPOWER 1983, September 1983, Knoxville, Tennessee.

"Integrating Solid Waste Management and Energy Planning," January 1983. Forthcoming publication in an American Planning Association compendium entitled, The Role of Planning in Our Nation's Energy Future.



"Multipurpose Planning of Hydroelectric Projects," Energy Planning Network, APA Energy Planning Division, December 1981.

"Multipurpose Planning of Small Hydro Projects: An Opportunity Assessment Approach." Presented at WATERPOWER 1981, June 1981, Washington, DC.

The Water Power Revival in Michigan," The Michigan Riparian, February 1981.

American Planning Association

American Planning Association, Energy Planning Division

National Association of Environmental Professionals



APPENDIX B

LIST OF INTERVIEWEES



APPENDIX B

LIST OF INTERVIEWEES 913th TAG

<u>Position</u>	<u>Years of Service</u>
Civilian Base Civil Engineering	14
Civilian, Engineering & Construction	14
Aircraft Maintenance Division	15
Civilian, AGE Shop	21
Civilian, Machine Shop	15
Civilian, Sheet Metal Shop	10
Civilian, Paint Shop	26
Civilian Welding Shop	10
Civilian, Pseudraulics Shop	15
Civilian, Corrosion Control Shop	18
Civilian, Fuel Cell Repair	3
Civilian, NDI Lab	6
Civilian, Engine & Prop Shop	12
Civilian, Avionics Shop	10
Civilian, Operations & Maintenance	15
Civilian, Receiving, Base Supply	26
Civilian, Medical Administrator	20
Civilian, Materials Manager, Base Supply	18
Civilian, Fuels Distribution, Base Supply	16
Civilian, Motor Pool Maintenance	15
Public Works NAS Willow Grove	3



**APPENDIX B
(Con't)**

<u>Position</u>	<u>Years of Experience</u>
Civilian Trash Disposal, PWO, NAS, Willow Grove	20
111th PaANG	
Deputy Commander Resources	18
Base Civil Engineering	4
Facility Manager	10
ACFT Field Maintenance	25
ACFT Dock Chief	20
ACFT Org. Maintenance	21
Fire Chief	20



APPENDIX C

LIST OF OUTSIDE AGENCIES



LIST OF OUTSIDE AGENCIES

Jim Beyers
National Archives and National Records Center
Research Assistance and Information
Washington, DC
202-523-3218

Steve Bern
Records Officer
Washington National Records Center
Suitland, Maryland
301-763-1710

Bill Lewis
Washington National Records Center
Suitland, Maryland
301-763-1710

Mr. Eldridge
Army Records Office
703-325-6179

Ed Reese
Records Office
Military Archives Division
Modern Military Headquarters Branch
Washington, DC
202-523-3340

Grace Rowe
Air Force Records Management
Air Force Records
Washington, DC
202-694-3527

Alan Guyer
Pennsylvania Geological Survey
Harrisburg, Pennsylvania
717-787-2167



**LIST OF OUTSIDE AGENCIES
(Con't)**

Steve Hearsh
U.S. EPA - Region III
Philadelphia, Pennsylvania
212-597-1177

Joe Feola
Pennsylvania Dept. of Environmental Resources
Norristown, Pennsylvania
215-270-1975

Paul Warmo, Water Quality Sanitarian
Pennsylvania Dept. of Environmental Resources
Norristown, Pennsylvania
215-270-1900

Tom Majusick
U.S. Dept. of Housing and Urban Development
Federal Emergency Management Agency
Philadelphia, Pennsylvania
215-597-3630

Gary Rohn
U.S. Army Corps of Engineers
Philadelphia, Pennsylvania
215-597-4808

Donald J. Baker, Engineer
Delaware River Basin Commission
West Trenton, New Jersey
609-883-9500



APPENDIX D

HAZARD ASSESSMENT RATING METHODOLOGY

**USAF INSTALLATION RESTORATION PROGRAM
HAZARD ASSESSMENT RATING METHODOLOGY**

BACKGROUND

The Department of Defense (DOD) has established a comprehensive program to identify, evaluate, and control problems associated with past disposal practices at DOD facilities. One of the actions required under this program is to:

"develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts." (Reference: DEQPPM 81-5, 11 December 1981).

Accordingly, the United States Air Force (USAF) has sought to establish a system to set priorities for taking further actions at sites based upon information gathered during the Records Search phase of its Installation Restoration Program (IRP).

The first site rating model was developed in June 1981 at a meeting with representatives from USAF Occupational Environmental Health Laboratory (OEHL), Air Force Engineering Services Center (AFESC), Engineering-Science (ES) and CH₂M Hill. The basis for this model was a system developed for EPA by JRB Associates of McLean, Virginia. The JRB model was modified to meet Air Force needs.

After using this model for 6 months at over 20 Air Force installations, certain inadequacies became apparent. Therefore, on January 26 and 27, 1982, representatives of USAF OEHL, AFESC, various major commands, Engineering Science, and CH₂M Hill met to address the inadequacies. The result of the meeting was a new site rating model designed to present a better picture of the hazards posed by sites at Air Force installations. The new rating model described in this presentation is referred to as the Hazard Assessment Rating Methodology.

PURPOSE

The purpose of the site rating model is to provide a relative ranking of sites of suspected contamination from hazardous substances. This model will assist the Air Force in setting priorities for follow-on site investigations and confirmation work under Phase II of IRP.

This rating system is used only after it has been determined that (1) potential for contamination exists (hazardous wastes present in sufficient quantity), and (2) potential for migration exists. A site can be deleted from consideration for rating on either basis.

DESCRIPTION OF MODEL

Like the other hazardous waste site ranking models, the U.S. Air Force's site rating model uses a scoring system to rank sites for priority attention. However, in developing this model, the designers incorporated some special features to meet specific DOD program needs.

The model uses data readily obtained during the Record Search portion (Phase I) of the IRP. Scoring judgments and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and the worst hazards at the site. Sites are given low scores only if there are clearly no hazards at the site. This approach meshes well with the policy for evaluating and setting restrictions on excess DOD properties.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: the possible receptors of the contamination, the waste and its characteristics, potential pathways for waste contaminant migration, and any efforts to contain the contaminants. Each of these categories contains a number of rating factors that are used in the overall hazard rating.

The receptors category rating is calculated by scoring each factor, multiplying by a factor weighting constant and adding the weighted scores to obtain a total category score.

The pathways category rating is based on evidence of contaminant migration or an evaluation of the highest potential (worst case) for contaminant migration along one of three pathways. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned and for direct evidence 100 points are assigned. If no evidence is found, the highest score among three possible routes is used. These routes are surface water migration, flooding, and ground-water migration. Evaluation of each route involves factors associated with the particular migration route. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score, while scores for sludges and solids are reduced.

The scores for each of the three categories are then added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Sites at which there is no containment are not reduced in score. Scores for sites with limited containment can be reduced by 5 percent. If a site is contained and well managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste management practices category factor to the sum of the scores for the other three categories.

HAZARD ASSESSMENT RATING METHODOLOGY FLOW CHART

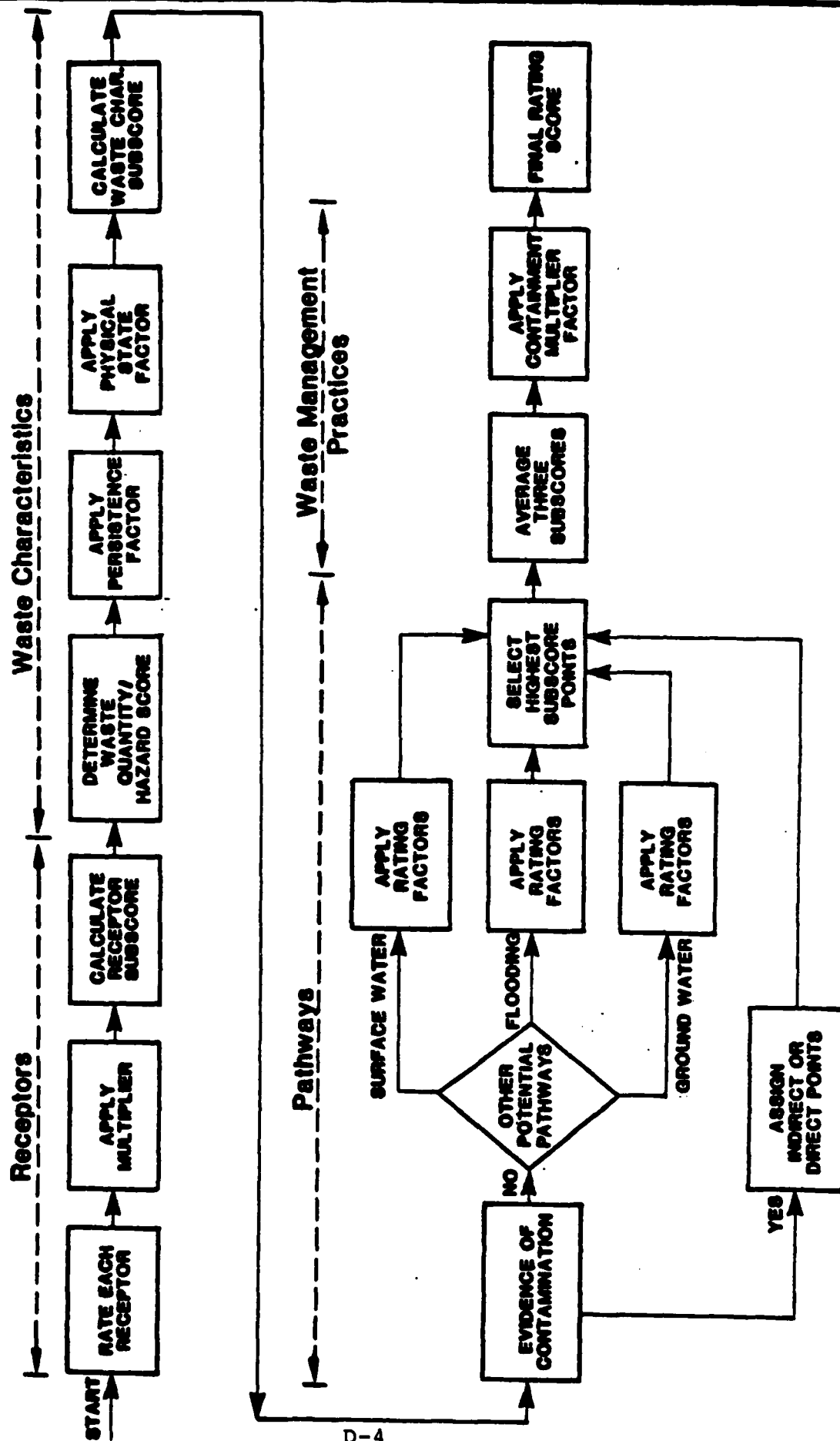


FIGURE 2 HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE _____
 LOCATION _____
 DATE OF OPERATION OR OCCURRENCE _____
 OWNER/OPERATOR _____
 COMMENTS/DESCRIPTION _____
 SITE RATED BY _____

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site		4		
B. Distance to nearest well		10		
C. Land use/zoning within 1 mile radius		3		
D. Distance to reservation boundary		6		
E. Critical environments within 1 mile radius of site		10		
F. Water quality of nearest surface water body		6		
G. Ground water use of uppermost aquifer		9		
H. Population served by surface water supply within 3 miles downstream of site		6		
I. Population served by ground-water supply within 3 miles of site		6		

Subtotals _____

Receptors subscore (100 X factor score subtotal/maximum score subtotal)

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) _____
2. Confidence level (C = confirmed, S = suspected) _____
3. Hazard rating (H = high, M = medium, L = low) _____

Factor Subscore A (from 20 to 100 based on factor score matrix)

B. Apply persistence factor

Factor Subscore A X Persistence Factor = Subscore B

_____ X _____ = _____

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

_____ X _____ = _____

FIGURE 2 (Continued)

II. PATHWAYS

- Rating Factor** **Factor Rating (0-3)** **Multiplier** **Factor Score** **Maximum Possible Score**
- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subcore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore _____

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water		8		
Net precipitation		6		
Surface erosion		8		
Surface permeability		6		
Rainfall intensity		8		

Subtotals _____

Subscore (100 x factor score subtotal/maximum score subtotal) _____

2. Flooding		1		
-------------	--	---	--	--

Subscore (100 x factor score/3) _____

3. Ground-water migration

Depth to ground water		8		
Net precipitation		6		
Soil permeability		8		
Subsurface flows		8		
Direct access to ground water		8		

Subtotals _____

Subscore (100 x factor score subtotal/maximum score subtotal) _____

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore _____

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors _____
Waste Characteristics _____
Pathways _____

Total _____ divided by 3 =

Gross Total Score _____

- B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

TABLE 1
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

Rating Factors	Rating Scale Levels				Multiplier
	0	1	2	3	
A. Population within 1,000 feet (includes on-base facilities)	0	1 - 25	26 - 100	Greater than 100	4
B. Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet	10
C. Land Use/Zoning (within 1 mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or Industrial	Residential	3
D. Distance to installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet	6
E. Critical environments (within 1 mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of economically important natural resources susceptible to contamination.	Major habitat of an endangered or threatened species; presence of recharge areas; major wetlands.	10
F. Water quality/use designation of nearest surface water body	Agricultural or industrial use.	Recreation, propagation and management of fish and wildlife.	Shellfish propagation and harvesting.	Potable water supplies	6
G. Ground-Water use of uppermost aquifer	Not used, other sources readily available.	Commercial, industrial, or irrigation, very limited other water sources.	Drinking water, municipal water available.	Drinking water, no municipal water available; commercial, industrial, or irrigation, no other water source available.	9
H. Population served by surface water supplies within 3 miles downstream of site	0	1 - 50	51 - 1,000	Greater than 1,000	6
I. Population served by aquifer supplies within 3 miles of site	0	1 - 50	51 - 1,000	Greater than 1,000	6

TABLE 1 (Continued)
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

II. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

- S = Small quantity (<5 tons or 20 drums of liquid)
- M = Moderate quantity (5 to 20 tons or 21 to 95 drums of liquid)
- L = Large quantity (>20 tons or 95 drums of liquid)

A-2 Confidence Level of Information

- C = Confirmed confidence level (minimum criteria below)
 - o Verbal reports from interviewer (at least 2) or written information from the records.
- S = Suspected confidence level
 - o No verbal reports or conflicting verbal reports and no written information from the records.
 - o Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicates that these wastes were disposed of at a site.

A-3 Hazard Rating

Hazard Category	Rating Scale Levels		
	0	1	2
Toxicity	Sax's Level 0 Flash point greater than 200°F	Sax's Level 1 Flash point at 140°F to 200°F	Sax's Level 2 Flash point at 60°F to 140°F
Ignitability	Flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point less than 60°F
Radioactivity	At or below background levels	1 to 3 times back-ground levels	3 to 5 times back-ground levels

Use the highest individual rating based on toxicity, ignitability and radioactivity and determine the hazard rating.

Hazard Rating	Points
High (H)	3
Medium (M)	2
Low (L)	1

TABLE 1 (Continued)

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

II. WASTE CHARACTERISTICS (Continued)

Waste Characteristic Matrix

Point Rating	Hazardous Waste Quantity	Confidence Level of Information	Hazard Rating
100	L	C	H
80	L	C	M
	M	C	M
70	L	S	H
60	S	C	H
	M	C	M
50	L	S	M
	L	C	L
	M	S	M
	S	C	M
40	S	S	H
	M	S	M
	M	C	L
	L	S	L
30	S	C	L
	M	S	L
	S	S	M
20	S	S	L

Notes:

For a site with more than one hazardous waste, the waste quantities may be added using the following rules:

Confidence Level

- o Confirmed confidence levels (C) can be added
- o Suspected confidence levels (S) can be added
- o Confirmed confidence levels cannot be added with suspected confidence levels

Waste Hazard Rating

- o Wastes with the same hazard rating can be added
- o Wastes with different hazard ratings can only be added in a downgrade mode, e.g., MCH + SCH = LCH if the total quantity is greater than 20 tons.

Example: Several wastes may be present at a site, each having an MCH designation (60 points). By adding the quantities of each waste, the designation may change to LCH (80 points). In this case, the correct point rating for the waste is 80.

D. Persistence Multiplier for Point Rating

Multiply Point Rating
From Part A by the Following

Persistence Criteria

Metals, polycyclic compounds, and halogenated hydrocarbons	1.0
Substituted and other ring compounds	0.9
Straight chain hydrocarbons	0.8
Easily biodegradable compounds	0.4

C. Physical State Multiplier

Multiply Point Total From
Parts A and B by the Following

Physical State

Liquid	1.0
Sludge	0.75
Solid	0.50

TABLE 1 (Continued)

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

III. PATHWAYS CATEGORY

A. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, ground water, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 POTENTIAL FOR SURFACE WATER CONTAMINATION

Rating Factor	Rating Scale Levels			Multiplier
	0	1	2	3
Distance to nearest surface water (includes drainage ditches and storm sewers)	Greater than 1 mile	2,001 feet to 1 mile	501 feet to 2,000 feet	0 to 500 feet
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.
Surface erosion	None	Slight	Moderate	Severe
Surface permeability	00 to 150 clay (>10 ⁻³ cm/sec)	150 to 300 clay (10 ⁻³ to 10 ⁻² cm/sec)	300 to 500 clay (10 ⁻² to 10 ⁻¹ cm/sec)	Greater than 500 clay (<10 ⁻¹ cm/sec)
Rainfall intensity based on 1 year 24-hr rainfall	<1.0 inch	1.0-2.0 inches	2.1-3.0 inches	>3.0 inches

B-2 POTENTIAL FOR FLOODING

Floodplain	Beyond 100-year floodplain	In 25-year flood-plain	In 10-year flood-plain	Floods annually	1
------------	----------------------------	------------------------	------------------------	-----------------	---

B-3 POTENTIAL FOR GROUND-WATER CONTAMINATION

Depth to ground water	Greater than 500 ft	50 to 500 feet	11 to 50 feet	0 to 10 feet	0
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.	0
Soil permeability	Greater than 500 clay (>10 ⁻³ cm/sec)	300 to 500 clay (10 ⁻³ to 10 ⁻² cm/sec)	150 to 300 clay (10 ⁻² to 10 ⁻¹ cm/sec)	00 to 150 clay (<10 ⁻³ cm/sec)	0
Subsurface flows	Bottom of site greater than 5 feet above high ground-water level	Bottom of site occasionally submerged	Bottom of site frequently submerged	Bottom of site located below mean ground-water level	0
Direct access to ground water (through faults, fractures, faulty well casings, subsidence fissures, etc.)	No evidence of risk	Low risk	Moderate risk	High risk	0

TABLE 1 (Continued)
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

IV. WASTE MANAGEMENT PRACTICES CATEGORY

a. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subcores.

b. WASTE MANAGEMENT PRACTICES FACTOR

The following multipliers are then applied to the total risk points (from A):

<u>Waste Management Practice</u>	<u>Multiplier</u>
No containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- o Clay cap or other impermeable cover
- o Leachate collection system
- o Liners in good condition
- o Adequate monitoring wells

Surface Impoundments:

- o Liners in good condition
- o Sound dikes and adequate freeboard
- o Adequate monitoring wells

Spills:

- o Quick spill cleanup action taken
- o Contaminated soil removed
- o Soil and/or water samples confirm total cleanup of the spill

Fire Protection Training Areas:

- o Concrete surface and berms
- o Oil/water separator for pretreatment of runoff
- o Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1 or III-B-3, then leave blank for calculation of factor score and maximum possible score.



APPENDIX E

SITE HARM SCORE CALCULATIONS

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE POL AREA - Site No. 1
 LOCATION Willow Grove ARF, near northern boundary
 DATE OF OPERATION OR OCCURRENCE 1958 - Present
 OWNER/OPERATOR Willow Grove ARF, Fuels Management
 COMMENTS/DESCRIPTION Storage area for JP-4 and other minor fuels. Documented spills
 SITE RATED BY ALD of JP-4. JP-4 tanks built on sand pads

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals 140 180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 78

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large)

L

2. Confidence level (C = confirmed, S = suspected)

C

3. Hazard rating (H = high, M = medium, L = low)

H

Factor Subscore A (from 20 to 100 based on factor score matrix)

100

B. Apply persistence factor

Factor Subscore A X Persistence Factor = Subscore B

100 x 0.80 = 80

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

80 x 1.0 = 80

III. PATHWAYS

- Rating Factor** **Factor Rating (0-3)** **Multiplier** **Factor Score** **Maximum Possible Score**
- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subcore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 100

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water	3	8	24	24
Net precipitation	2	6	12	18
Surface erosion	0	8	0	24
Surface permeability	0	6	0	18
Rainfall intensity	2	8	16	24

Subtotals 52 108Subscore (100 x factor score subtotal/maximum score subtotal) 48

2. Flooding	0	1	0	3
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Subscore (100 x factor score/3) 0

3. Ground-water migration

Depth to ground water	2	8	16	24
Net precipitation	2	6	12	18
Soil permeability	3	8	24	24
Subsurface flows	1	8	8	24
Direct access to ground water	3	8	24	24

Subtotals 84 114Subscore (100 x factor score subtotal/maximum score subtotal) 74

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 100**IV. WASTE MANAGEMENT PRACTICES**

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	<u>78</u>
Waste Characteristics	<u>80</u>
Pathways	<u>100</u>
Total <u>258</u> divided by 3	<u>86</u>
	Gross Total Score

- B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

<u>86</u>	x	<u>0.95</u>	=	<u>82</u>
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HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE Open Waste Storage Area # 42 - Site No. 2
 LOCATION Willow Grove ARF, near northern boundary
 DATE OF OPERATION OR OCCURRENCE 1958 - Present
 OWNER/OPERATOR Willow Grove ARF Base Supply
 COMMENTS/DESCRIPTION Uncontained open storage area for drums, spills, and leaks of
 SITE HAZED BY AID waste oils and solvents.

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			140	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal)

78

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large)

L

2. Confidence level (C = confirmed, S = suspected)

C

3. Hazard rating (H = high, M = medium, L = low)

M

Factor Subscore A (from 20 to 100 based on factor score matrix)

80

B. Apply persistence factor

Factor Subscore A X Persistence Factor = Subscore B

80 x 1.0 = 80

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

80 x 1.0 = 80

III. PATHWAYS

- Rating Factor** **Factor Rating (0-3)** **Multiplier** **Factor Score** **Maximum Possible Score**
- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subcore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 80

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water	3	8	24	24
Net precipitation	2	6	12	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			58	108

Subscore (100 x factor score subtotal/maximum score subtotal) 54

2. Flooding	0	1	0	3
Subscore (100 x factor score/3)			<u>0</u>	

3. Ground-water migration

Depth to ground water	2	8	16	24
Net precipitation	2	6	12	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			44	114

Subscore (100 x factor score subtotal/maximum score subtotal) 39

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 80**IV. WASTE MANAGEMENT PRACTICES**

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	<u>78</u>
Waste Characteristics	<u>80</u>
Pathways	<u>80</u>
Total <u>238</u> divided by 3 =	<u>79</u>
Gross Total Score	

- B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

79 x 1.0 = 79

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE Ponding Basin - Site No. 3
 LOCATION Willow Grove ARF near northern boundary
 DATE OF OPERATION OR OCCURRENCE 1958 - Present
 OWNER/OPERATOR Willow Grove NAS - Public Works
 COMMENTS/DESCRIPTION Unlined storm runoff retention pond. Receiver runoff from ARF
 SITE RATED BY ALD and part of NAS; presense of oily seeps.

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals 140 180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 78

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S

2. Confidence level (C = confirmed, S = suspected) S

3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 40

B. Apply persistence factor

Factor Subscore A X Persistence Factor = Subscore B

40 x 0.80 = 32

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

32 x 1.0 = 32

III. PATHWAYS

- Rating Factor** **Factor Rating (0-3)** **Multiplier** **Factor Score** **Maximum Possible Score**
- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subcore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 100

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water	3	8	24	24
Net precipitation	2	6	12	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			66	108

Subscore (100 x factor score subtotal/maximum score subtotal)

61

2. Flooding

	3	1	3	3
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Subscore (100 x factor score/3)

100

3. Ground-water migration

Depth to ground water	3	8	24	24
Net precipitation	2	6	12	18
Soil permeability	2	8	16	24
Subsurface flows	3	8	24	24
Direct access to ground water	3	8	24	24
Subtotals			100	114

Subscore (100 x factor score subtotal/maximum score subtotal)

88

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore

100**IV. WASTE MANAGEMENT PRACTICES**

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	<u>78</u>
Waste Characteristics	<u>32</u>
Pathways	<u>100</u>

Total 210 divided by 3 =70

Gross Total Score

- B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

70x 1.0 =70

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE Wash rack Area - Site No. 4
 LOCATION Willow Grove ARF, near center of facility
 DATE OF OPERATION OR OCCURRENCE 1958 - Present
 OWNER/OPERATOR Willow Grove ARF
 COMMENTS/DESCRIPTION Discharge of wash rack water (detergents, solvents, paint
 SITE RATED BY ALD strippers, oils) to groundwater via unlined trickling
filter.

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals 140 180

Receptors subcore (100 X factor score subtotal/maximum score subtotal) 78

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- Waste quantity (S = small, M = medium, L = large) M
- Confidence level (C = confirmed, S = suspected) C
- Hazard rating (H = high, M = medium, L = low) M

Factor Subcore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor

Factor Subcore A X Persistence Factor = Subcore B

$$\underline{60} \times \underline{1.0} = \underline{60}$$

C. Apply physical state multiplier

Subcore B X Physical State Multiplier = Waste Characteristics Subcore

$$\underline{60} \times \underline{1.0} = \underline{60}$$

III. PATHWAYS

- Rating Factor** **Factor Rating (0-3)** **Multiplier** **Factor Score** **Maximum Possible Score**
- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subcore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 80

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water	3	8	24	24
Net precipitation	2	6	12	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			58	108

Subscore (100 x factor score subtotal/maximum score subtotal) 54

2. Flooding

Subscore (100 x factor score/3) 0

3. Ground-water migration

Depth to ground water	3	8	24	24
Net precipitation	2	6	12	18
Soil permeability	2	8	16	24
Subsurface flows	2	8	16	24
Direct access to ground water	2	8	16	24
Subtotals			84	114

Subscore (100 x factor score subtotal/maximum score subtotal) 71

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 80**IV. WASTE MANAGEMENT PRACTICES**

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	78
Waste Characteristics	60
Pathways	80
Total <u>218</u> divided by 3 =	<u>73</u>

Gross Total Score

- B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

<u>73</u>	x	<u>0.95</u>	=	<u>69</u>
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HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE Building 330 Waste Oil Storage Area - Site No. 5
 LOCATION Willow Grove ARE, near southeast boundary
 DATE OF OPERATION OR OCCURRENCE 1970-1980
 OWNER/OPERATOR PA, ANG
 COMMENTS/DESCRIPTION Site used for waste oils in bowser; overfilling and spillage
 SITE RATED BY R. Kane caused contamination

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals 140 180

Receptors subcore (100 X factor score subtotal/maximum score subtotal) 78

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S

2. Confidence level (C = confirmed, S = suspected) C

3. Hazard rating (H = high, M = medium, L = low) H

Factor Subcore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor

Factor Subcore A X Persistence Factor = Subcore B

60 X 0.80 = 48

C. Apply physical state multiplier

Subcore B X Physical State Multiplier = Waste Characteristics Subcore

48 X 1.0 = 48

III. PATHWAYS

- Rating Factor** **Factor Rating (0-3)** **Multiplier** **Factor Score** **Maximum Possible Score**
- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 80

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water	3	8	24	24
Net precipitation	2	6	12	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			58	108

Subscore (100 x factor score subtotal/maximum score subtotal)

54

2. Flooding

0	1	0	
Subscore (100 x factor score/3)			0

3. Ground-water migration

Depth to ground water	2	8	16	24
Net precipitation	2	6	12	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			44	114

Subscore (100 x factor score subtotal/maximum score subtotal)

39

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 80**IV. WASTE MANAGEMENT PRACTICES**

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	78
Waste Characteristics	48
Pathways	80
Total <u>206</u> divided by 3 =	<u>69</u>
Gross Total Score	

- B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

69 x 1.0 = 69

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE Heating Plant - Site No. 6
 LOCATION Willow Grove ARF, near center of facility
 DATE OF OPERATION OR OCCURRENCE 1959 - Present
 OWNER/OPERATOR Outside contractor for USAF
 COMMENTS/DESCRIPTION Storage area for #6 fuel oil and miscellaneous fuels, solvents.
 SITE HAZED BY ALD and water softeners; evidence of one #6 fuel oil spill.

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals 140 180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 78

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S

2. Confidence level (C = confirmed, S = suspected) C

3. Hazard rating (H = high, M = medium, L = low) M

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor

Factor Subscore A X Persistence Factor = Subscore B

50 X 0.80 = 40

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

40 X 1.0 = 40

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subcore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 80

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water	3	8	24	24
Net precipitation	2	6	12	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24

Subtotals 58 108Subscore (100 x factor score subtotal/maximum score subtotal) 54

2. Flooding

Subscore (100 x factor score/3) 0

3. Ground-water migration

Depth to ground water	2	8	16	24
Net precipitation	2	6	12	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24

Subtotals 44 114Subscore (100 x factor score subtotal/maximum score subtotal) 39

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 80**IV. WASTE MANAGEMENT PRACTICES**

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	<u>78</u>
Waste Characteristics	<u>40</u>
Pathways	<u>80</u>

Total 198 divided by 3 = 66

Gross Total Score

- B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

66 x 1.0 = 66

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE Old well house - Site No. 7
 LOCATION Willow Grove ARE, northern boundary corner
 DATE OF OPERATION OR OCCURRENCE 1962 - Present
 OWNER/OPERATOR Willow Grove ARE, Civil Engineering
 COMMENTS/DESCRIPTION Paint and paint thinners stored inside and outside of building
 SITE RATED BY ALD housing abandoned unplugged well

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			140	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal)

78

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large)

S

2. Confidence level (C = confirmed, S = suspected)

S

3. Hazard rating (H = high, M = medium, L = low)

M

Factor Subscore A (from 20 to 100 based on factor score matrix)

30

B. Apply persistence factor

Factor Subscore A X Persistence Factor = Subscore B

$$30 \times 0.9 = 27$$

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

$$27 \times 1.0 = 27$$

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subcore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.**

Subscore 0

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.**

1. Surface water migration

Distance to nearest surface water	3	8	24	24
Net precipitation	2	6	12	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			66	108
Subscore (100 x factor score subtotal/maximum score subtotal)				61

2. Flooding

	0	1	0	3
Subscore (100 x factor score/3)				0

3. Ground-water migration

Depth to ground water	2	8	16	24
Net precipitation	2	6	12	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	3	8	24	24
Subtotals			76	114
Subscore (100 x factor score subtotal/maximum score subtotal)				67

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 67**IV. WASTE MANAGEMENT PRACTICES**

- A. Average the three subscores for receptors, waste characteristics, and pathways.**

Receptors	78
Waste Characteristics	27
Pathways	67
Total <u>172</u> divided by 3 =	57
Gross Total Score	

- B. Apply factor for waste containment from waste management practices**

Gross Total Score x Waste Management Practices Factor = Final Score

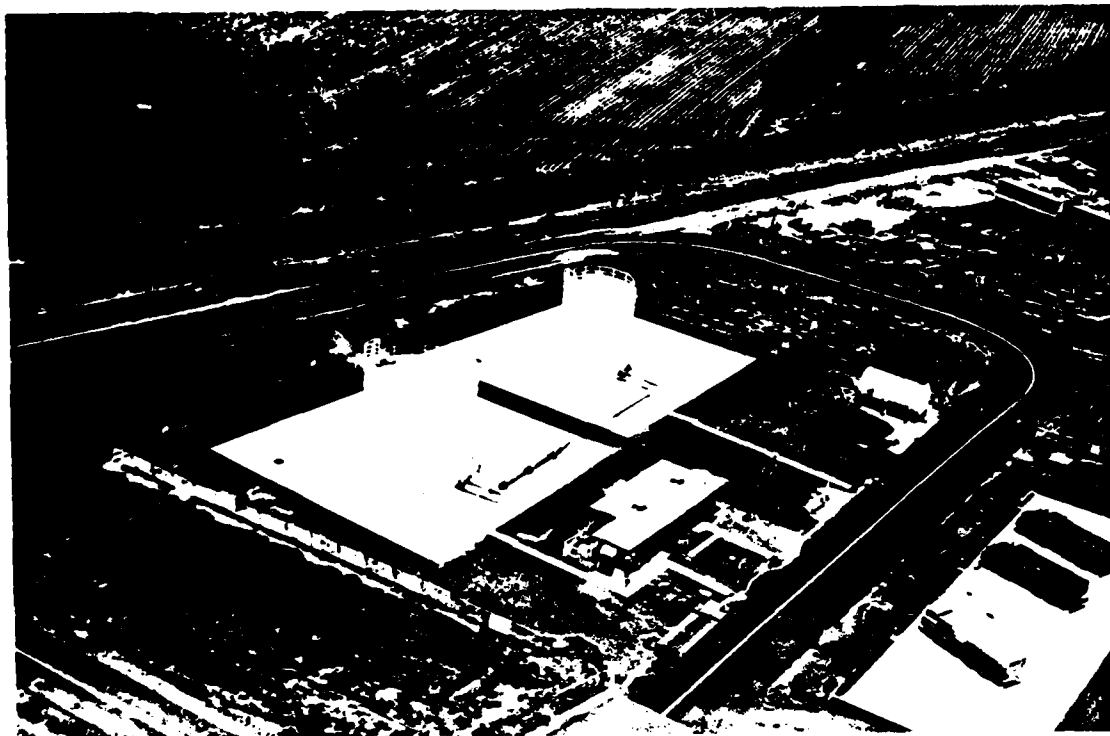
54 x 1.0 = 54



APPENDIX F

PHOTOGRAPHS

SITE NO. 1 - POL AREA



POL AREA, AERIAL VIEW FROM WEST



POL AREA, AERIAL VIEW FROM SOUTH
SHOWING PROXIMITY TO PONDING BASIN

SITE NO. 2 - OPEN STORAGE AREA #42

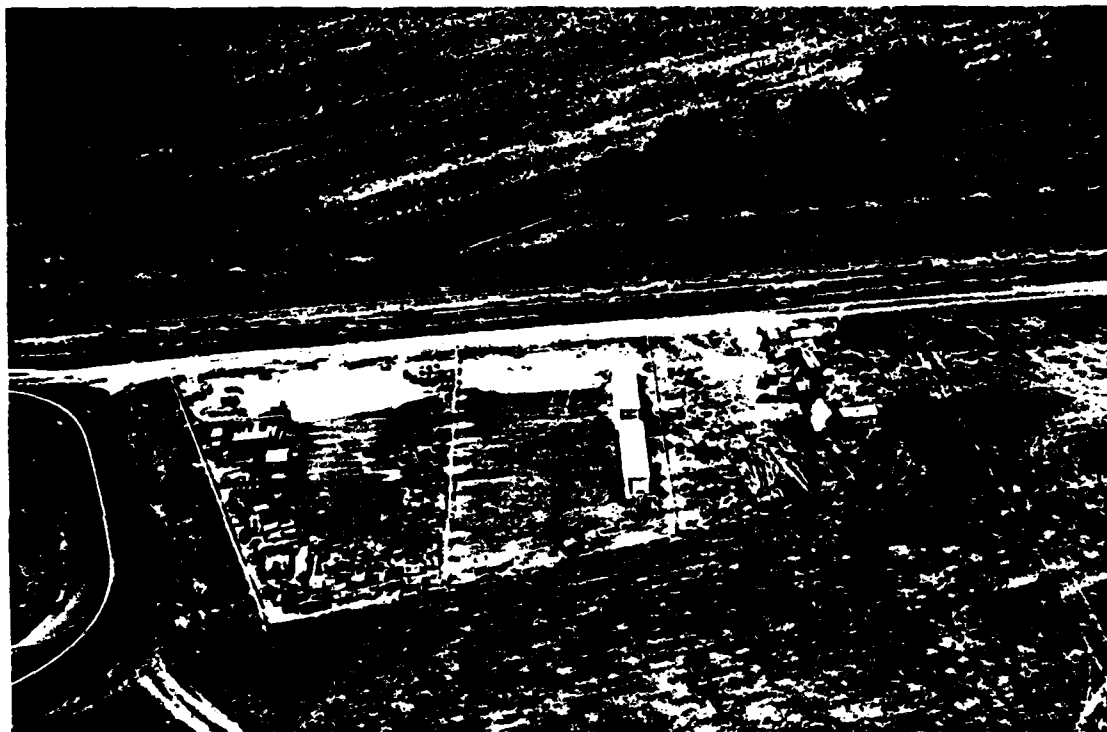


VIEW FROM WEST SIDE



DRUMS OF WASTE ENGINE OIL AND HYDRAULIC OIL

SITE NO. 2 - OPEN STORAGE AREA #42
(CONTINUED)



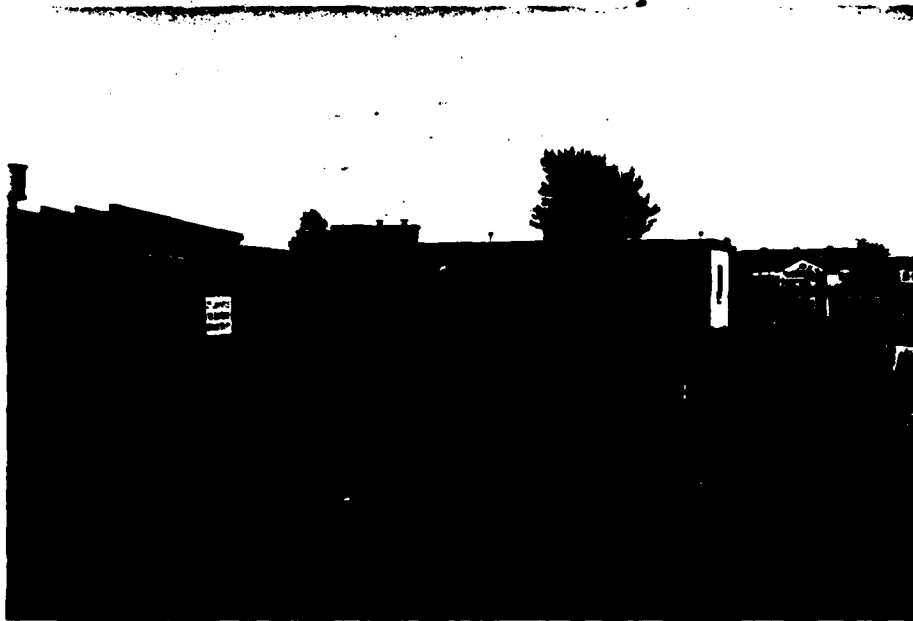
AERIAL VIEW FROM SOUTH

SITE NO. 3 - PONDING BASIN

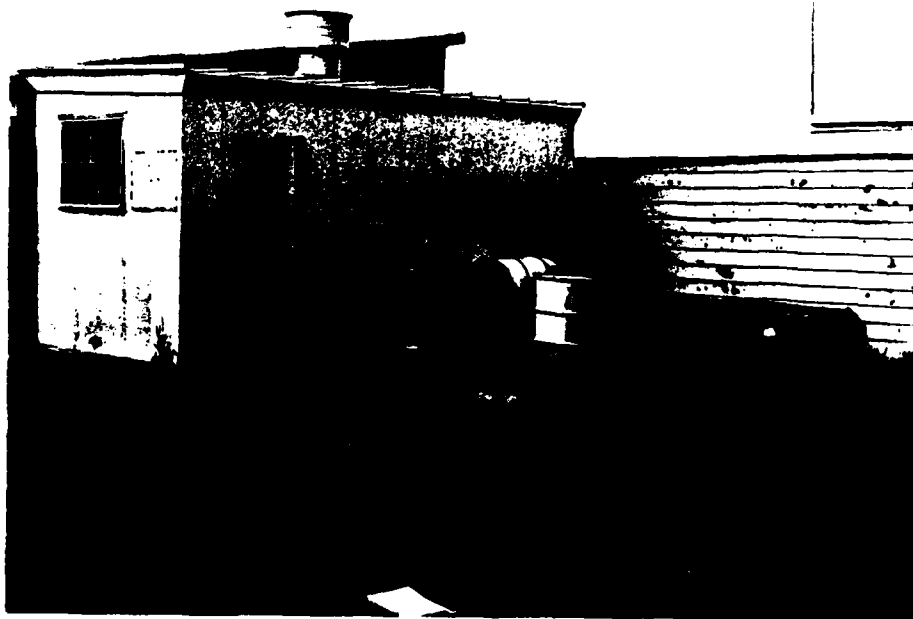


AERIAL VIEW FROM NORTH

SITE NO. 4 - WASHRACK AREA

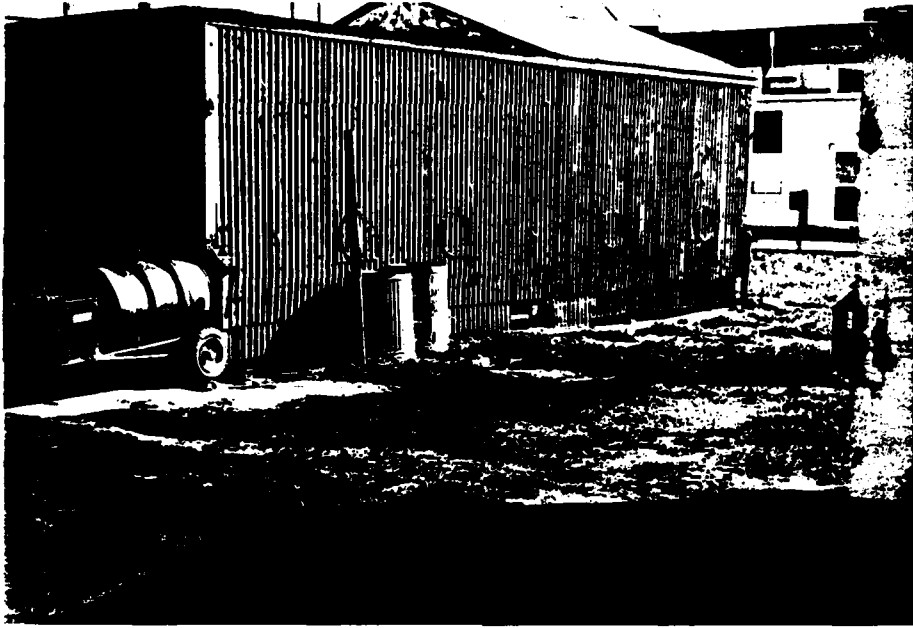


WASHRACK AREA TREATMENT SYSTEM, VIEWED FROM NORTH



WASHRACK AREA, SOUTH SIDE OF BUILDING # 215

SITE NO. 5 - BUILDING #330



WASTE OIL STORAGE AREA SOUTH OF BUILDING #330

SITE NO. 5 - BUILDING #330
(CONTINUED)



WASTE OIL STORAGE AREA SOUTH OF BUILDING #330
GROUND DISCOLORATION

SITE NO. 6 - HEATING PLANT



NO. 6 FUEL OIL SPILL BENEATH TANK #221

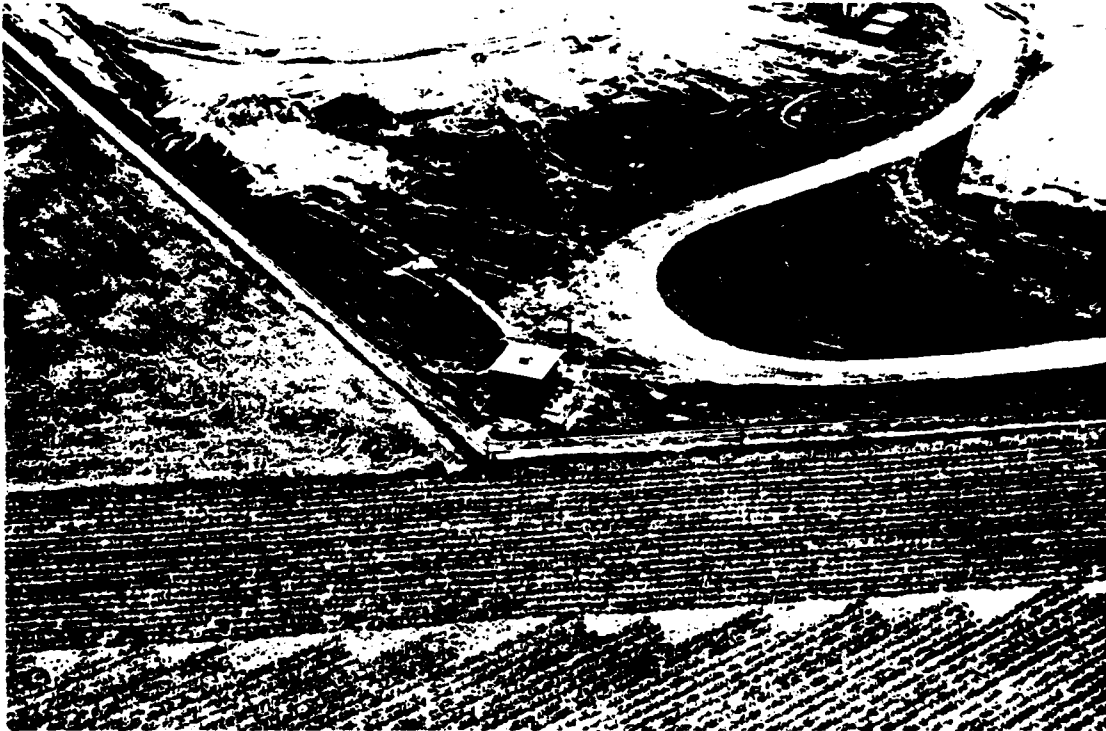
SITE NO. 6 - HEATING PLANT

(CONTINUED)



CHEMICAL STORAGE OUTSIDE OF BUILDING #212

SITE NO. 7 - OLD WELL HOUSE



AERIAL VIEW FROM NORTH



APPENDIX G

GLOSSARY OF TERMS AND ABBREVIATIONS



APPENDIX G

GLOSSARY OF TERMS AND ABBREVIATIONS

ACCUMULATION POINT	A designated location for the accumulation of wastes prior to removal from the installation.
ACFT MAINT	Aircraft Maintenance
AF	Air Force
AFB	Air Force Base
AFESC	Air Force Engineering and Services Center
AFFF	Aqueous Film Forming Foam (a fire extinguishing agent).
AFR	Air Force Regulation
AFRES	Air Force Reserve Command
Ag	Chemical symbol for silver.
AGE	Aerospace Ground Equipment
Al	Chemical symbol for aluminum.
ALLUVIUM	Materials eroded, transported, and deposited by surface water.
ANG	Air National Guard
ARTESIAN	Groundwater contained under hydrostatic pressure.
AQUIFER	A geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring.

AROMATIC	Organic chemical compounds in which the carbon atoms are arranged into a ring with special electron stability associated. Aromatic compounds are often more reactive than nonaromatics.
AVGAS	Aviation Gasoline (contains lead).
Ba	Chemical symbol for barium.
BIOACCUMULATE	Tendency of elements or compounds to accumulate or buildup in the tissues of living organisms when they are exposed to elements in their environments, e.g., heavy metals.
BIODEGRADABLE	The characteristic of a substance to be broken down from complex to simple compounds by microorganisms.
BOWSER	A mobile tank, usually 1,000 gallons or less in capacity.
BX	Base Exchange
CaCO_3	Chemical symbol for calcium carbonate.
Cd	Chemical symbol for cadmium.
CE	Civil Engineering
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIRCA	About, used to indicate an approximate date.
CN	Chemical symbol for cyanide.
COD	Chemical Oxygen Demand, a measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water.
COE	Corps of Engineers

CONFINED AQUIFER	An aquifer bounded above and below by geologic units of distinctly lower permeability than that of the aquifer itself.
CONFINING UNIT	A geologic unit with low permeability which restricts the vertical movement of groundwater.
Cr	Chemical symbol for chromium.
Cu	Chemical symbol for copper.
2,4-D	Abbreviation for 2,4-dichlorophenoxyacetic acid, a common weed killer and defoliant.
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DIP	The angle at which a geologic structural surface is inclined from the horizontal.
DOD	Department of Defense
DOT	Department of Transportation
DOWNGRADIENT	In the direction of decreasing hydraulic static head; the direction in which groundwater flows.
DPDO	Defense Property Disposal Office
DUMP	An uncontrolled land disposal site where solid and/or liquid wastes are deposited.
EFFLUENT	A liquid waste, untreated or treated, that discharges into the environment.
EP	Extraction Procedure - the EPA standard laboratory procedure for simulation of leachate generation.
EPA	U.S. Environmental Protection Agency

INSTALLATION RESTORATION PROGRAM PHASE I: RECORDS
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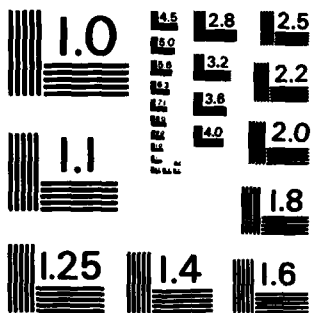
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



EROSION	The wearing away of land surface by wind, water, or chemical processes.
FAA	Federal Aviation Administration
FAULT	A fracture in rock along the adjacent rock surfaces which are differentially displaced.
Fe.	Chemical symbol for iron.
FLOOD PLAIN	The low land and relatively flat areas adjoining inland and coastal areas of the mainland and off-shore islands, including, at a minimum, areas subject to 1 percent or greater chance of flooding in any given year.
FLOW PATH	The direction of movement of groundwater as governed principally by the hydraulic gradient.
FMS	Field Maintenance Squadron
FPTA	Fire Protection Training Area
FY	Fiscal Year
GC/MS	Gas chromatograph/mass spectrophotometer, an analytical instrument for qualitative and quantitative measurement of organic compounds having a maximum molecular weight of 800.
GROUNDWATER	Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure.
GROUNDWATER RESERVOIR	The earth materials and the intervening open spaces that contain groundwater.
HALON	A fluorocarbon fire extinguishing compound.
HALOGEN	The class of chemical elements including fluorine, chlorine, bromine, and iodine.

HARM**Hazard Assessment Rating Methodology****HAZARDOUS SUBSTANCE**

Under CERCLA, the definition of hazardous substance includes:

- All substances regulated under Paragraphs 311 and 307 of the Clean Water Act (except oil).
- All substances regulated under Paragraph 3001 of the Solid Waste Disposal Act.
- All substances regulated under Paragraph 112 of the Clean Air Act.
- All substances which the Administrator of EPA has acted against under Paragraph 7 of the Toxic Substance Control Act.
- Additional substances designated under Paragraph 102 of the Superfund Bill.

HAZARDOUS WASTE

As defined in RCRA, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical/chemical, or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

**HAZARDOUS WASTE
GENERATION**

The act or process of producing a hazardous waste.

HEAVY METALS

Metallic elements, including the transition series, which include many elements required for plant and animal nutrition in trace concentrations but which become toxic at higher concentrations.

Hg	Chemical symbol for mercury
HQ	Headquarters
HYDROCARBONS	Organic chemical compounds composed of hydrogen and carbon atoms chemically bonded. Hydrocarbons may be straight chain, cyclic, branched chain, aromatic, or polycyclic, depending upon arrangement of carbon atoms. Halogenated hydrocarbons are hydrocarbons in which one or more hydrogen atoms has been replaced by a halogen atom.
INFILTRATION	The movement of water across the atmosphere-soil interface.
IRP	Installation Restoration Program
ISOPACH	Graphic presentation of geologic data, including lines of equal unit thickness that may be based on confirmed (drill hole) data or indirect geophysical measurement.
JP-4	Jet Propulsion Fuel (unleaded) No. 4, military jet fuel.
LEACHATE	A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water.
LITHOLOGY	The description of the physical character of a rock.
LOESS	An essentially unconsolidated unstratified calcareous silt; commonly homogeneous, permeable, and buff to gray in color.
LYSIMETER	A vacuum operated sampling device used for extracting pore waters at various depths within the unsaturated zone.

MEK.	Methyl Ethyl Ketone
METALS	See "Heavy Metals".
MGD	Million gallons per day.
MOA	Military Operating Area
MIK	Methyl Isobutyl Ketone
MOGAS	Motor Gasoline
Mn	Chemical symbol for manganese.
MONITORING WELL	A well used to obtain groundwater samples and to measure groundwater elevation
MSL	Mean Sea Level
NDI	Nondestructive inspection.
NET PRECIPITATION	The amount of annual precipitation minus annual evaporation.
Ni	Chemical symbol for nickel.
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OEHL	Occupational and Environmental Health Laboratory
OIC	Officer-In-Charge
ORGANIC	Being, containing, or relating to carbon compounds, especially in which hydrocarbon is attached to carbon.
OSI	Office of Special Investigations

O&G	Symbols for oil and grease.
Pb	Chemical symbol for lead.
PCB	Polychlorinated Biphenyl - liquids used as a dielectrics in electrical equipment.
PCE	Tetrachloroethylene
PERCOLATION	Movement of moisture by gravity or hydrostatic pressure through interstices of unsaturated rock or soil.
PERMEABILITY	The capacity of a porous rock, soil, or sediment for transmitting a fluid.
PERSISTENCE	As applied to chemicals, those which are very stable and remain in the environment in their original form for an extended period of time.
PD-680	Kerosene-based cleaning solvent
pH	Negative logarithm of hydrogen ion concentration.
PL	Public Law
POL	Petroleum, Oils, and Lubricants
POLLUTANT	Any introduced gas, liquid, or solid that makes a resource unit for a specific purpose.
POLYCYCLIC COMPOUND	All compounds in which carbon atoms are arranged into two or more rings, usually in nature.
POTENTIOMETRIC SURFACE	The surface to which water in an aquifer would rise in tightly cased wells open to the aquifer.
PPB	Parts per billion by weight.
PPM	Parts per million by weight.



PRECIPITATION	Rainfall.
QUATERNARY MATERIALS	The second period of the Cenozoic geologic era, following the Tertiary, and including the last 2 to 3 million years.
RCRA	Resource Conservation and Recovery Act of 1976
RECEPTORS	The potential impact group or resource for a waste contamination source.
RECHARGE AREA	A surface area in which surface water or precipitation percolates through the unsaturated zone and eventually reaches the zone of saturation.
RECHARGE	The addition of water to the groundwater system by natural or artificial processes.
RIPARIAN	Living or located on a riverbank.
SANITARY LANDFILL	A site using an engineered method of disposing solid wastes on land.
SATURATED ZONE	Soil or geologic materials in which all voids are filled with water.
SAX's TOXICITY	A rating method for evaluating the toxicity of chemical materials.
SCS	U.S. Department of Agriculture Soil Conservation Service
SOLID WASTE	Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment, or air pollution control facility, and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, or agricultural operations and from community activities, but does not include solid or dissolved materials in domestic



sewage; solid or dissolved materials in irrigation return flows; industrial discharges which are point source subject to permits under Section 402 of the Federal Water Pollution control Act, as amended (86 USC 880); or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923).

SPILL

Any unplanned release or discharge of a material onto or into the air, land, or water.

STORAGE OF HAZARDOUS WASTE

Containment, either on a temporary basis or for a longer period, in such manner as not to constitute permanent disposal of such hazardous waste.

STP

Sewage Treatment Plant

2,4,5-T

Abbreviation for 2,4,5-trichlorophenoxyacetic acid, a common herbicide.

TAG

Tactical Airlift Group

TCE

Trichloroethylene

TDS

Total Dissolved Solids

TOC

Total Organic Carbon

TOXICITY

The ability of a material to produce injury or disease upon exposure, ingestion, inhalation, or assimilation by a living organism.

TRANSMISSIVITY

The rate at which water is transmitted through a unit width of aquifer under a hydraulic gradient.



TREATMENT OF HAZARDOUS WASTE	Any method, technique, or process including neutralization designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize the waste or so as to render the waste non-hazardous.
TSD	Treatment, storage, or disposal.
TSDF	Treatment, storage, or disposal facility.
UPGRADIENT	In the direction of increasing hydraulic static head; the direction from which groundwater flows.
USAF	United States Air Force
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WANG	Wisconsin Air National Guard
WATER TABLE	Surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere.
WWTP	Wastewater Treatment Plant
Zn	Chemical symbol for zinc

APPENDIX H

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